

SCIENTIFIC RESEARCH

McGRAW-HILL'S NEWS MAGAZINE FOR SCIENTISTS

FEBRUARY 1967



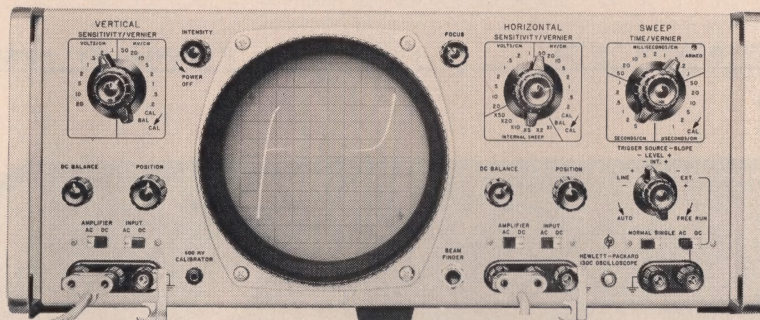
Harvey Brooks of Harvard

BETTER USE OF OUR NATIONAL LABS 52

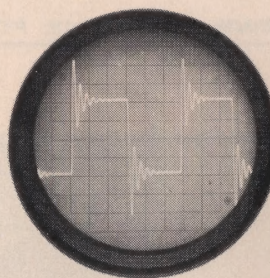
ALSO IN THIS ISSUE:

Camera on a changing AAAS	26
Electron-spin spectroscopy	42
The laser in chemistry	46

Put either of these high-sensitivity 500 kHz hp scopes on your bench and...

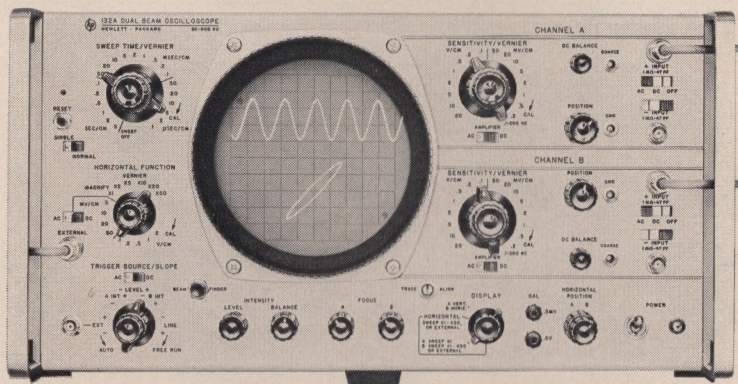


130C 200 $\mu\text{v}/\text{cm}$ sensitivity scope



Trace on 130C at left shows how identical vertical and horizontal amplifiers facilitate display of component characteristics. As shown in adjacent trace, you get a clear picture of low-level signals with high 200 $\mu\text{v}/\text{cm}$ sensitivity, DC to 500 kHz.

GET PERFORMANCE WHERE IT COUNTS



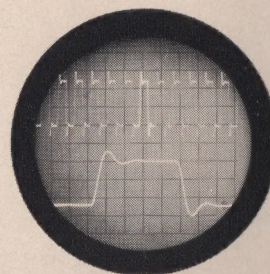
132A 100 $\mu\text{v}/\text{cm}$ sensitivity dual beam scope

A powerful combination of 200 $\mu\text{v}/\text{cm}$ sensitivity, 500 kHz bandwidth, balanced input on all 16 ranges, and identical X & Y amplifiers makes the hp 130C an ideal match for lab, production and systems measurements. Its high sensitivity permits direct measurement of low-level balanced signals without external amplification. Amplifiers may also be used single-ended—either ac or dc coupled. Other features include sweep expansion to X50 for accurate measurement of waveform details.

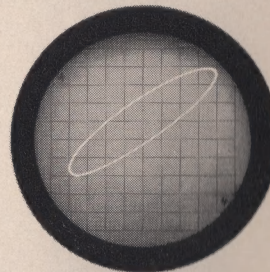
Extreme dual-beam versatility of the 132A makes it clearly superior for diverse electronic, scientific and bio-medical applications. Versatility is enhanced by Channel A & B amplifiers that have 100 $\mu\text{v}/\text{cm}$ sensitivity with high stability and a bandwidth of 150 kHz at 100 $\mu\text{v}/\text{cm}$, increasing to 500 kHz at 1 mv/cm and above. Amplifiers reject common mode signals such as hum pick-up by 20,000:1 for clear displays of low-level differential signals. Amplifier outputs are provided for driving voltmeters, tape recorders or other equipment.

Both scopes provide automatic triggering which produces a baseline even in the absence of an input signal—provides stable triggering when the signal is applied, and enhances fast, easy set-up. Both have a beam finder, as well as an internal graticule CRT for making accurate measurements from any viewing angle. Both have characteristic hp reliability and have proved themselves in adverse environments. Prices: 130C, \$695.00; 132A, \$1275.00.

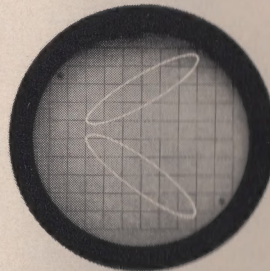
Ask your hp Field Engineer for complete specifications, or write to Hewlett-Packard, Palo Alto, California, 94304. Call (415) 326-7000. In Europe: 54 Route des Acacias, Geneva.



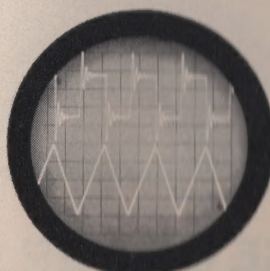
Two completely independent beams provide simultaneous X-Y and time plots... as shown on 132A at left. Adjacent trace shows how you can display a signal and magnify any portion of it on Channel B, using beam intensification to show location of fast sweep.



Accurate phase measurements of small or low level signals are possible through the use of identical amplifiers on both channels. 100 $\mu\text{v}/\text{cm}$ amplifiers have less than 2° phase difference for signals to 50 kHz.



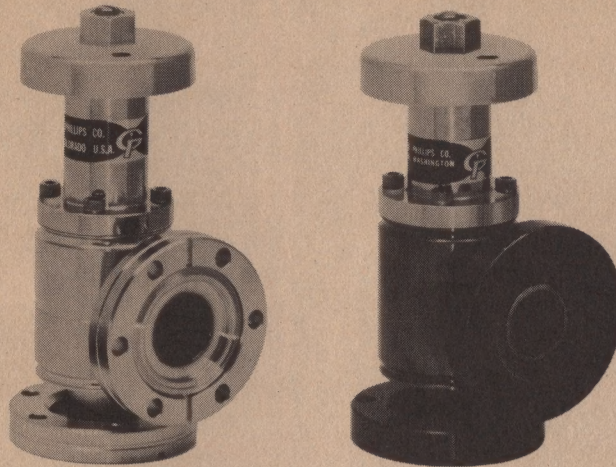
You get numerous dual X-Y measurements using 5 mv/cm 300 kHz horizontal capability, plus two 500 kHz vertical amplifiers.



Make accurate time comparisons of two signals displayed at the same sweep speed.

HEWLETT **hp** PACKARD
An extra measure of performance

Compare . . .



with any other make,
and the superior performance of
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(new or used) is obvious!

The **GP** Series 204 vacuum valve pictured on the left is brand new, it's bakeable to 450°C and it seals mass spectrometer leak tight.

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GP bakeable valves are the only vacuum valves that deliver this kind of reliability and

that's because Granville-Phillips has had more experience at building valves. *There are more **GP** ultra-high vacuum valves in use today than all other makes combined.*

The new Granville-Phillips vacuum valve is better than ever. One and two-inch valves now provide *replaceable gold seals* for improved performance and easier maintenance.

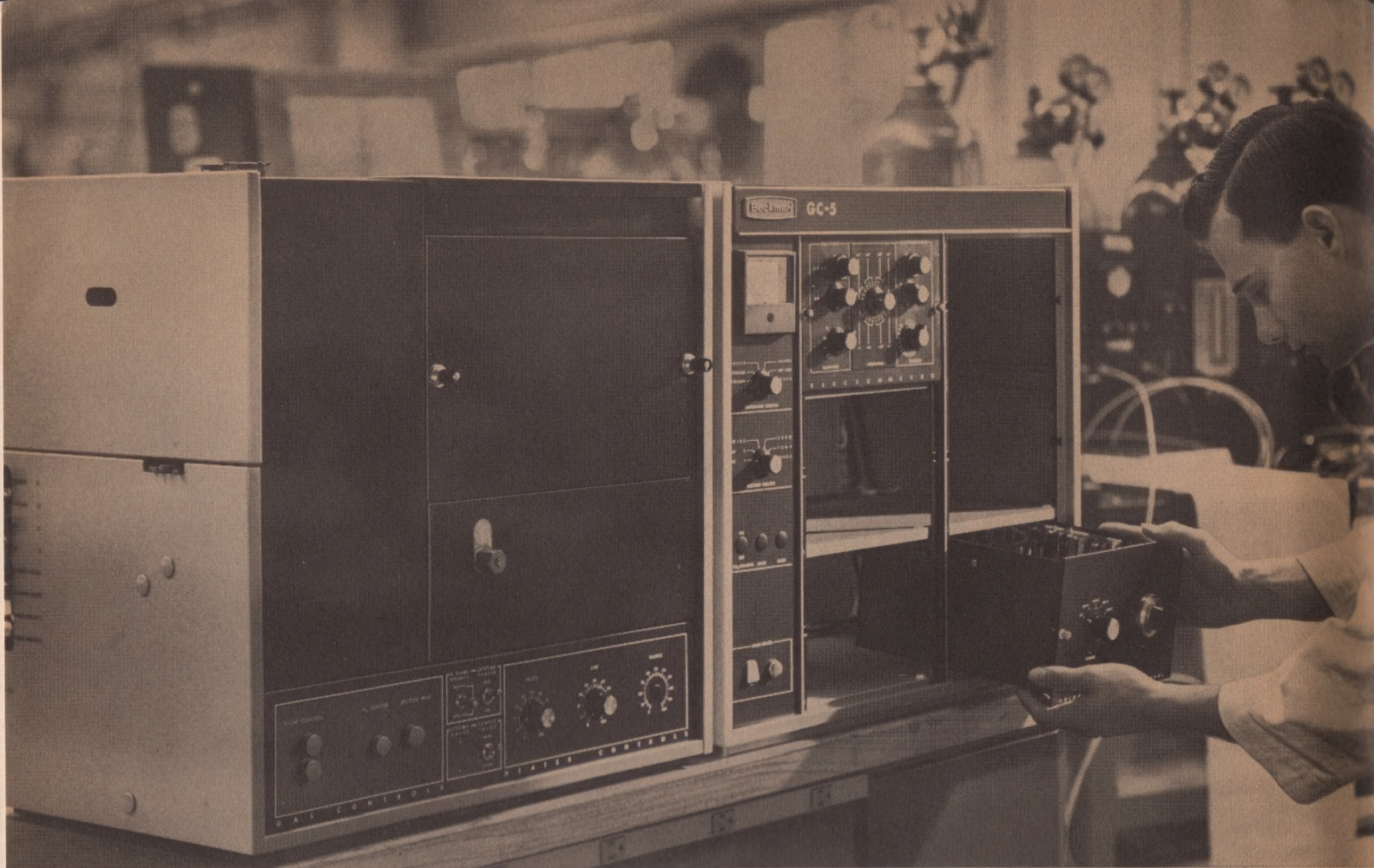
For more specific information on how a **GP** valve can help improve your vacuum system, write for **GP** Data Sheet No. 204-1B.



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NEWS



Paul Kotin—to direct new environmental health effort at NIH (p 38)

13 THE SCIENCE WORLD

- 13 CERN decides organization of 300-Bev accelerator lab
- 15 Information system to link U. S., Canadian universities
- 17 Birth of stellar-planetary system found by Texas scientist
- 19 Chemical industry urged to help fight cancer
- 21 Lasers may be medical hazard, AAAS told
- 23 NASA considering orbiting radio telescope plan

25 WASHINGTON SCIENCE OUTLOOK

Government taking longer view of environmental effects; Congress to scan new lab-animal rules; FDA seeks control over medical devices

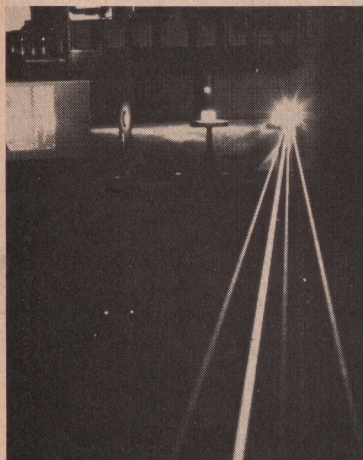
26 A CHANGING AAAS IN A CHANGING WORLD: a photo report

38 PAUL KOTIN: CZAR OF THE 'NEW TOXICOLOGY'

39 REP. EVINS: DISPENSER OF SCIENCE FUNDS

40 USPHS GETS A NEW LOOK

FEATURES



The laser — a general-purpose research tool for chemistry (p 46)

34 THE ROUS CANCER VIRUS — REALLY A BACTERIUM?

Bacteria can switch to a virus form: a look at 'eccentric' genes, heredity and infection

42 MOLECULAR STUDIES WITH ELECTRON-SPIN SPECTROSCOPY

Once restricted to physics laboratories, this technique is finding applications in chemistry and biology

46 THE LASER IN CHEMISTRY

After a slow start, the commercial laser is on its way to becoming a general-purpose chemical research tool

52 A MATTER OF OPINION: HARVEY BROOKS

We need more freedom for our national labs if we are to make the most of their potential as a national resource

IN OUR NEXT ISSUE

PATTERN RECOGNITION

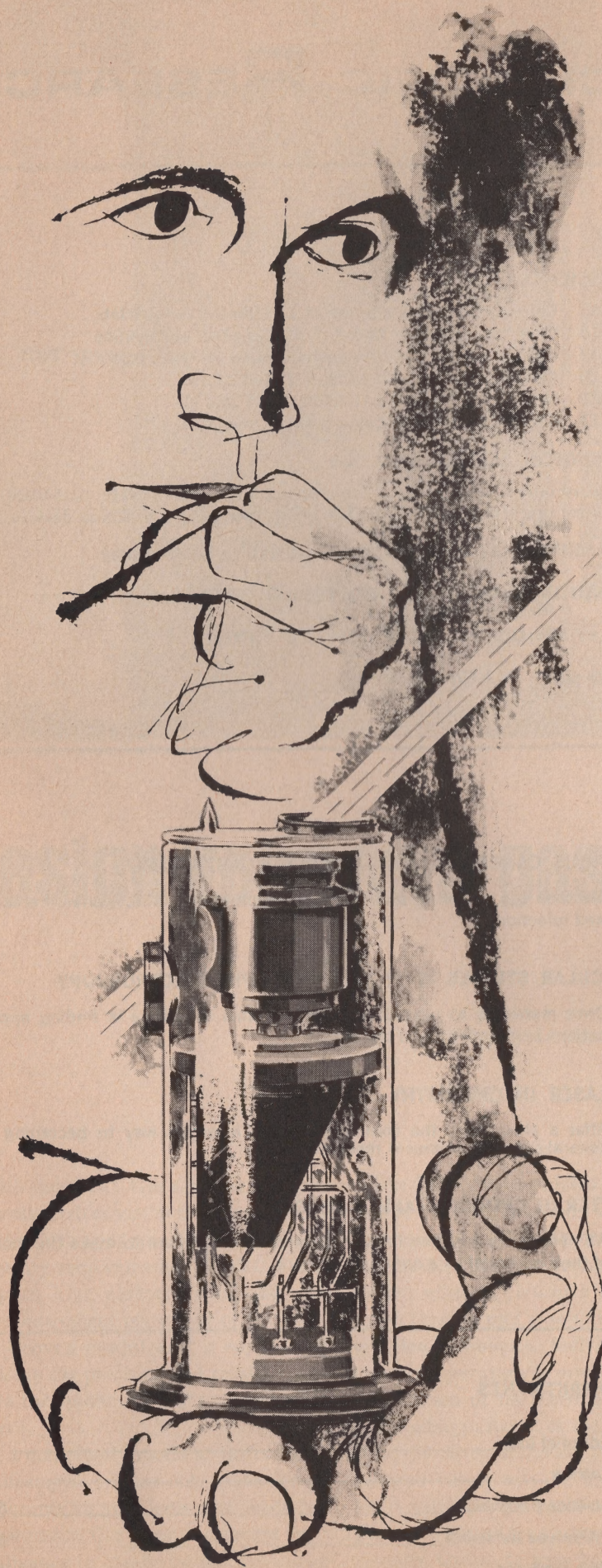
THE FY-68 FEDERAL BUDGET

NEXT STEP FOR THE 200-BEV

A PROFILE OF OST

OTHER DEPARTMENTS

Editorial page	5
Letters	6
Science Bookshelf	55
Literature Available	59
New Products	61



What's new in ultra-relativistic particle counting?

Amperex has just developed an electron multiplier assembly, specially designed to incorporate a thin film converter for detection of ultra-relativistic particles. Recent research has shown that the secondary emission yield from a highly porous but thin film of cesium iodide may be sufficient for detection and detailed studies of single ultra-relativistic particles.

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High efficiency tetrode-collection optics are also available in the Amperex photomultiplier series XP1020, XP1210 and 58AVP, all of which offer unmatched accuracy of measurement when the light flux is minimal and flash duration is extremely short.

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A time to fight — (2)

A month ago in this space we submitted that with science facing a financial crisis in Washington, the scientific community should "mobilize to fight for those allocations for research [that] the national interest demands . . . should insist on participating fully in the decisions on how the allocations are to be made . . . [and] should get itself more effectively represented within the precincts of those who decide how federal monies will be spent."

The problem of "securing constructive legislation" for science came up at the annual meeting of the American Association for the Advancement of Science in December. There one speaker, D. S. Greenberg, staff writer for AAAS, recalled how, for almost two decades until just a year or two ago, a Congress that accepted the national value of scientific research on faith, almost blindly, could hardly seem to do enough in financing research; and the beneficiaries of this largesse—principally NSF and NIH—were not constrained to learn the art of getting along with—and across to—the Congress.

Now all is changed. As Greenberg put it,

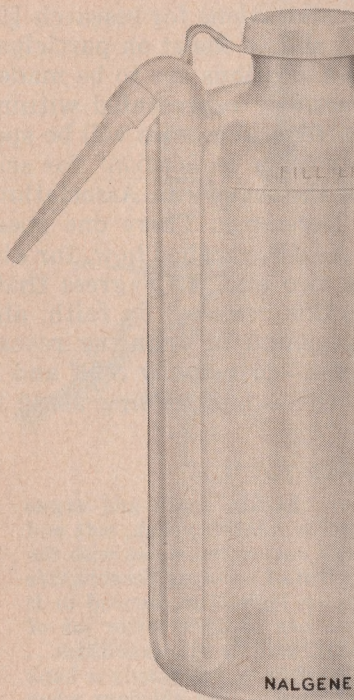
Science, justifiably or not, now has to scrap and argue for its share of resources. . . . After a relatively rich, soft and protected childhood, science is now out on the street with the tough guys, and it faces the problem of securing constructive legislation rather than having such legislation handed to it by kindly congressmen. . . . Science has to do a better job of making known its value, its needs, and its vulnerabilities. . . . it has to understand that the Congress is not simply a bank to which it presents withdrawal slips. . . . The old days when everything came easily. . . . are gone, and now science must compete for public support with many other sectors.

A specific example of the kind of predicament that can result is the case of the science community's relations with Rep. Joe L. Evins (*see p 39*), whom it largely ignored while he was second-ranking member of the subcommittee that passes on NSF, NASA and OST budgets among others, and with whom—to its great regret—it finds it has little rapport now that he is chairman of the subcommittee.

What to do about this problem is the corollary of the problem of how science must organize itself to be in a position to make recommendations to Congress on fund allocations. Both are fundamentally problems of human communication, and as with most communications problems, the biggest and most difficult part of the solution is recognition of the fact that a communications block exists, and of the need for overcoming it. What this means is that scientists must accept that cultivating friendships and understanding on Capitol Hill is not toadying, and that paying far more attention than hitherto to modern techniques of presentation are not to be dismissed as press-agentry.

Some disciplines, and subdisciplines such as high-energy physics and nuclear medicine, have been taking the first steps toward organizing formal liaison with the federal government, and a very few, like the American Chemical Society with its Committee on Chemistry and Public Affairs, already have Washington representation. Some major disciplines, however, say their present form of organization may not embark on such activities. It appears to us that all major scientific disciplines need to take a long hard look at whether Washington liaison is not, in today's world, a matter of self-preservation.

A REVOLUTIONARY WASH BOTTLE! NEW CONCEPT! NEW DESIGN!



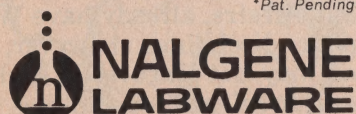
The new Nalgene® Wash Bottle incorporates a revolutionary technique.* The dispensing tube is molded as an integral part of the polyethylene bottle. This unit construction means the bottle can't leak!

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More features? The integral snap-on closure can't be lost—it's molded as part of the bottle. Large neck opening for easy filling—this wash bottle fills just like a regular bottle. Available in 125, 250, 500, 1000 ml sizes. Assortable with other Nalgene Labware for maximum discounts.

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*Pat. Pending



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LETTERS

WHICH IS WHO

Dear Sir:

I enjoy reading *SCIENTIFIC RESEARCH*. I would enjoy it even more if you would kindly tell your Mr. Bernhard the rules about *who* and *which*, and that a mosquito is not *who*. See the November issue p. 41 (legend, right column) and p. 43, parasite rhythms, ninth line.

F. B. HUTT

Dept. of Poultry Husbandry
N.Y. State College of Agriculture
Cornell University
Ithaca, N. Y.

(Of course Professor Hutt is quite correct about the flagrant misuse of "who". If there is any excuse it is to be found in the fact that, as a former biophysicist, Editor Bernhard still thinks of even the single-celled creatures with a certain nostalgic fondness.—ED.)

ANOTHER KIND WORD

Dear Sir:

Somehow or other I have misplaced one of the numbers of *SCIENTIFIC RESEARCH* that was quite important to me. It is Vol. 1, No. 9, September 1966. . . . Incidentally, you are publishing one of the finest magazines of its type that I have seen. I read it from cover to cover.

S. A. COHN

Department of Anatomy
University of Tennessee
Memphis, Tennessee

AND ANOTHER (FROM ITALY)

Dear Sir:

I have been receiving for some time your beautiful review, and above all, I should like to congratulate you and your contributors on its scientific level and its editorial qualities. . . .

GILBERTO BERNARDINI

Professor
Scuola Normale Superiore
Pisa, Italy

REFORMING DUTCH UNIVERSITIES

Dear Sir:

In *SCIENTIFIC RESEARCH* (of July 1966, page 15), there appeared an overseas scienceletter: "In Germany: a 2nd Mössbauer effect."

The necessity of the reforms as initiated by Mössbauer at German Universities is perhaps even more urgent at universities in the Netherlands.

For this reason and as a stimulant for discussion I would like to publish a translation of this scienceletter in "Universiteit en

Hogeschool," a bimonthly published for all those scientists active in research or education at the universities. . . .

DR. I. P. DIRK

Laboratorium Voor Organische
Scheikunde der Universiteit
Van Amsterdam
Nieuwe Achtergracht 129

'MATTER OF CONSCIENCE'

Dear Sir:

Your editorial "A Matter of Conscience" (SR, Oct '66, 5) caused me to reflect on the barbarous methods used to force people through taxes to support such research and on the equally barbarous and morally repugnant act of forcing people through the draft laws to use the results. It is hypocritical for a government-supported scientist to speak of his freedoms.

WILLIAM HUVELLOW
Livermore, Calif.

STANDARDIZING INSTRUMENTATION

Dear Sir:

I was pleased to read your article on the Standard Nuclear Instrument Module (NIM) System in the November issue of *SCIENTIFIC RESEARCH* (SR, Nov. '66, 11). However, I would like to point out that there was opposition from only a few manufacturers while most adopted a "wait and see" attitude. This point is academic, however, since with the essentially universal acceptance of the NIM System in the U. S., whatever resistance did exist has certainly evaporated.

All of the AEC National Laboratories were represented on the organizing committee that met on February 26, 1964 and instructed the NIM Committee to produce a standard module system. The laboratories maintained an active interest throughout the development and all participated in the Committee deliberations that resulted in the NIM System.

Mention should be made of the substantial contributions of George A. Holt of the Oak Ridge National Laboratory and Dick A. Mack of the Lawrence Radiation Laboratory at Berkeley who were responsible for the first prototypes and who have been active throughout the NIM System development.

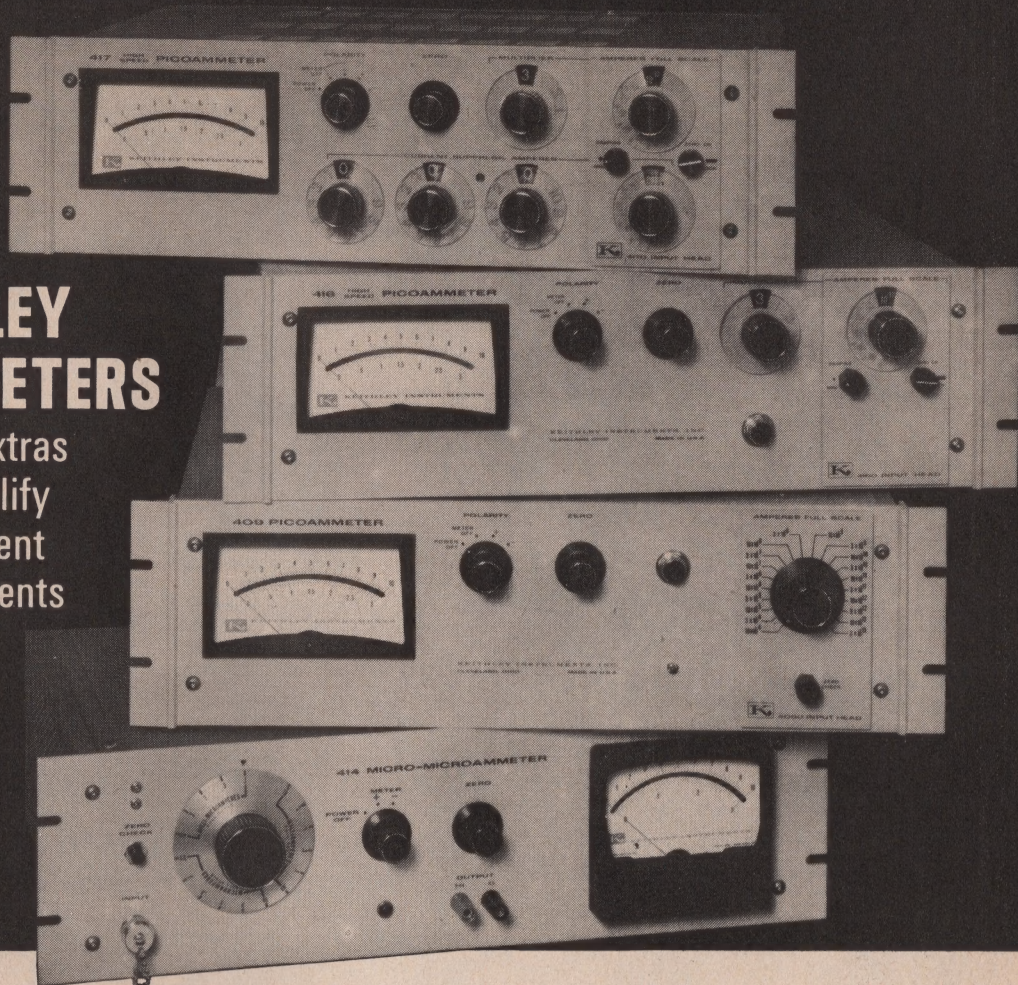
All told, your write-up gives the story clearly and concisely.

LOUIS COSTRELL

National Bureau of Standards
Chairman, AEC Committee on
Nuclear Instrument Modules

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give the extras
that simplify
your current
measurements



We'll stack-up our low-level current measuring instruments against the toughest applications you've got. As a group, Keithley picoammeters let you choose almost any combination of speed, sensitivity, stability, or cost. Individually, our Models 417, 416, 414 and 409 make it easy to narrow your choice. Each has been proved reliable. Each features less than 1 millivolt input drop, less than 1% f. s. noise and a handy recorder output.

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gas chromatographs, photo and electron multipliers or wherever a little extra is required for low current measurements. Buy the 417 for \$850; or the 416 for \$685.

The ultra-low-drift Keithley 409 allows long-term measurement of currents as low as 3×10^{-13} ampere f.s. It's solid state, offers a range of 3×10^{-13} to 10^{-10} ampere f.s. and drifts less than 1% per day. It's a \$550 medium-cost workhorse for use with photomultipliers, ion gauges, ion chambers and semiconductors.

For low-cost production testing and measurements falling between 10^{-2} to 10^{-10} ampere f.s., we make the 414. It has 17 ranges, drift of less than 2% in 8 hours and costs only \$325. It'll measure back currents in diodes and transistors, currents in phototubes and photocells.

Check us for more details. We'll supply technical literature or a convincing in-plant picoammeter demonstration. Or both.

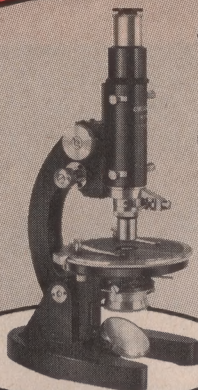


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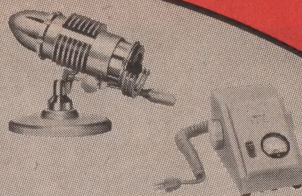
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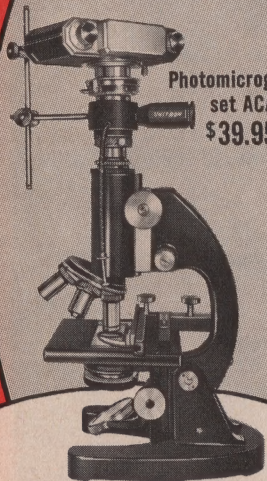
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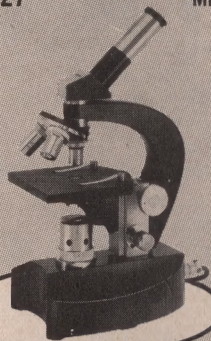
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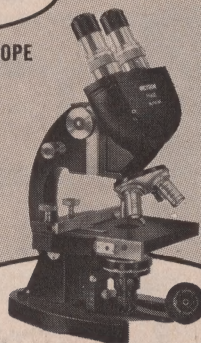
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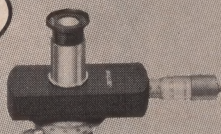
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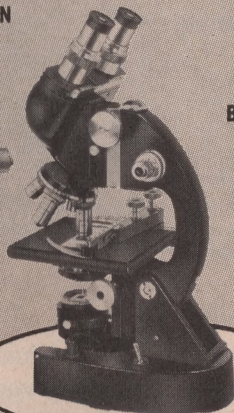
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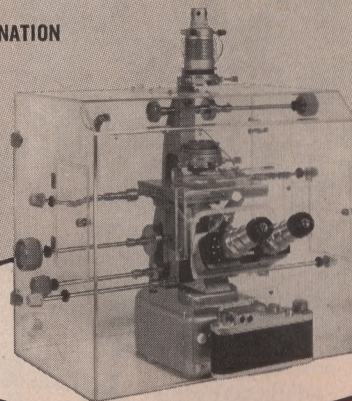


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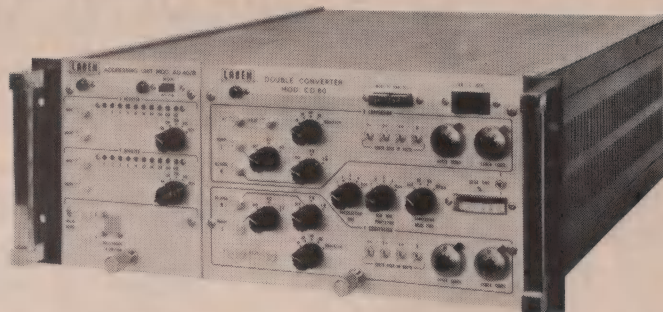
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Packard

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Operation in ready or delayed coincidence/anticoincidence mode. High stability. Differential linearity better than 1%

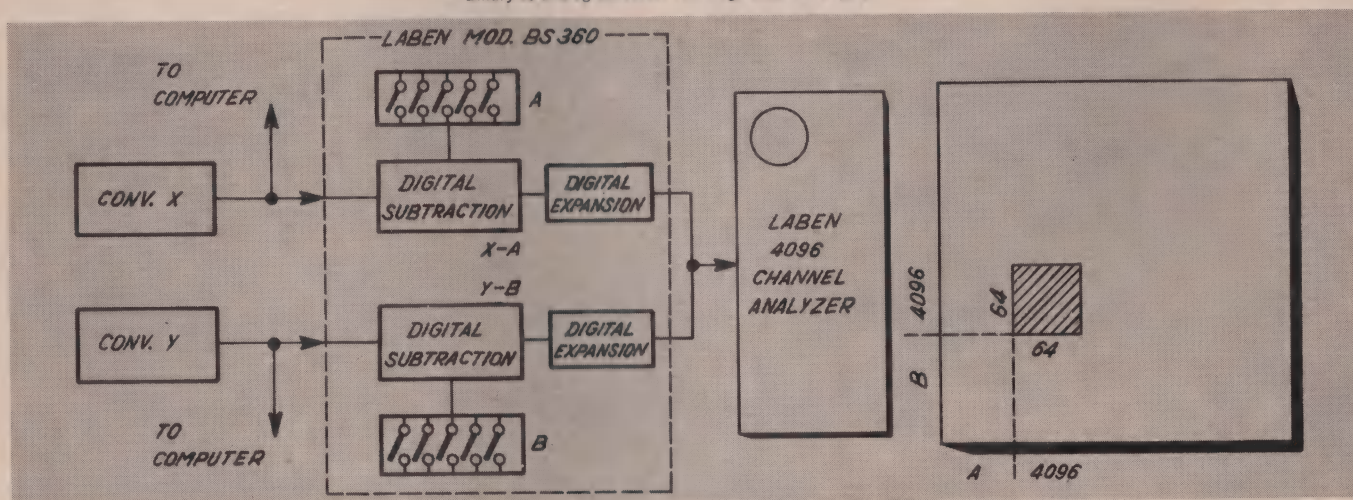
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- Parallel output of information in pure binary code
- Either automatic or externally controlled data transfer
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4096 x 4096

- Twin 4096-channel converter
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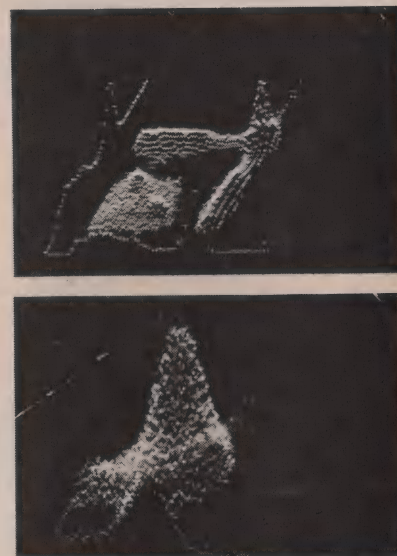
- Two 4096-channel address registers operating at 16 Mc/sec.



The LABEN Mod. BS 360 unit in combination with a 4096-channel analyzer allows a three-dimensional spectrum to be measured on a 64 x 64 or 128 x 32 channel matrix selected in any area of the 4096 x 4096 channel spectrum.

The selection of the origin point of the aforementioned matrix is accomplished by presetting the numbers A and B through appropriate switches and subtracting these numbers in digital form from the address X and Y, respectively.

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FEBRUARY, 1967 • SCIENTIFIC RESEARCH



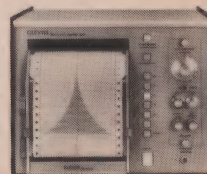
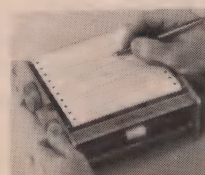
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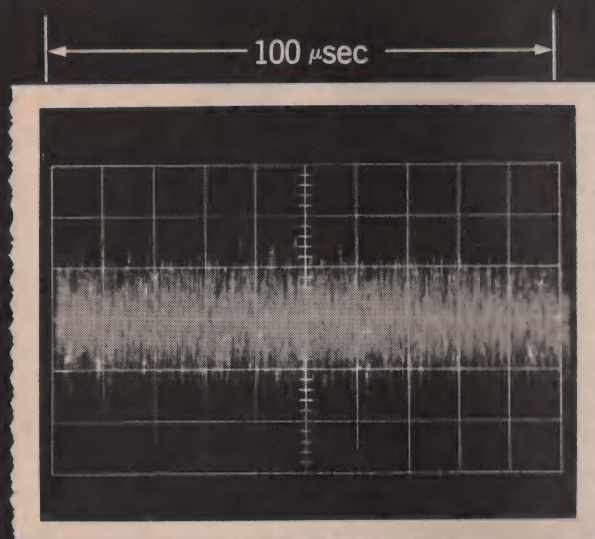


Photo #1—Input to Model TDH-9
SENSITIVITY: 5 V/cm
TIME: 10 μ sec/cm
NOISE-TO-SIGNAL RATIO: 10:1

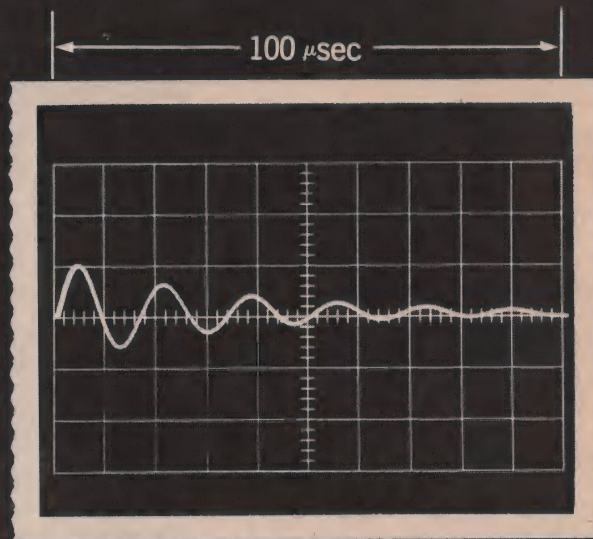
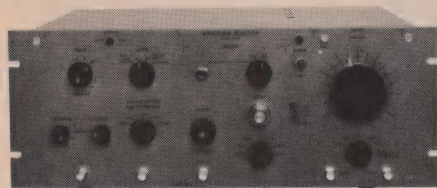


Photo #2—Output of Model TDH-9
SENSITIVITY: 5 V/cm
TIME: 10 μ sec/cm
TDH-9 VOLTAGE GAIN: 10



PAR Model TDH-9 Waveform Eductor

Photo #1 is an actual oscillogram of a signal obscured by noise — a situation unfortunately prevalent in many research areas such as studies of biomedical evoked potentials, seismology, spectroscopy, fluorescent lifetime studies, and vibration analysis. Photo #2 shows the dramatic improvement in signal-to-noise ratio when the noisy signal was processed

by the PAR Model TDH-9 Waveform Eductor.

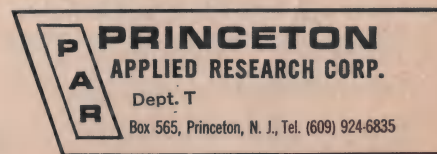
This new instrument employs a highly efficient waveform-averaging technique, and at the same time offers the fastest sweep rates obtainable in signal processing equipment of the signal-averaging type. Sweep durations as short as 100 microseconds, with dwell times per channel of 1 microsecond, are obtainable. The high resolution capability of the Model TDH-9 allows observation of waveforms or transients which have heretofore been unresolvable by averaging instruments employing a greater number of channels.

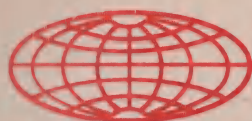
Although the Model TDH-9 Waveform Eductor sells for only \$4,200,

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Tough choice for CERN: possible sites for 300-Bev accelerator range across Europe

Geneva

300-BEV LAB ORGANIZATION FIXED BY CERN COUNCIL

High-energy physics on a world scale is advancing rapidly. The U.S. has picked a site for its 200-Bev accelerator and the Soviet 70-Bev accelerator is almost completed, with progress made toward a 1,000-Bev machine (SR, Jan. '66, 11).

Now the world's other major accelerator project is well on its way to reality—the 300-Bev proton synchrotron of the European Organization for Nuclear Research (CERN).

At the CERN Council meeting late in December, the 13 member-states made two important decisions:

- the \$350-million, 300-Bev accelerator laboratory will be governed by the same convention as that which governs CERN;

- a "neutral" committee of representatives from Denmark, the Netherlands and Switzerland will examine the final report on the characteristics of the nine sites (see map) proposed for the machine. These three countries have not sub-

mitted any site proposals.

In June the Council will consider a modified version of its convention to allow incorporation of the proposed accelerator and to hear the neutral committee report. Final decision on a site will be in two steps: in September a special Council session will narrow the choice to three sites, followed by a final decision in December. Accelerator construction will then start in 1969.

The Council allocated supplementary budget of \$1 million for preparatory work on the big accelerator this year. So far some \$3 million in supplementary funds has been assigned to the task. The Council approved the CERN basic 1967 budget of \$40 million, including the go-ahead for construction of the giant 3.5-meter dia bubble chamber (SR, Oct. '66, 15) which could be used with the 300-Bev machine.

With the siting decision less than a year away, bets are already being taken on the most likely candidates. Front runners at the moment are Le Luc in the south of France and Mundford near Cambridge, Eng-

land. But those who favor these sites point out that international politics may make it advisable to choose a site in one of the smaller countries to avoid friction among the "big four" (Great Britain, France, Germany and Italy).

Similar site criteria apply to the 300-Bev accelerator as apply to the U.S. 200-Bev machine. Terrain must be flat and extremely stable (the magnet ring with a total circumference of 7.5 km needs to be placed on a foundation stable enough to guarantee that misalignments stay within 0.15 mm over about 100 meters). And the site must be large enough to accommodate the machine (2.4 km diameter) with its experimental areas and have scope for future extensions.

Although the design plans for the accelerator are still very tentative—based on the "Amaldi Report" put out by the CERN European Committee for Future Accelerators in 1963—general guidelines for the machine have been laid down. It will be a proton alternating-gradient synchrotron of the same basic design as the proposed 200-Bev machine. Provisional specifications envisage a 200-Mev linear-accelerator injector feeding an 8-Bev synchrotron accelerator which will inject particles into the final 300-Bev ring. The beam intensity will be 3×10^{13} protons/pulse with a pulse repetition rate of one every 3.3 sec.

One interesting aspect of the whole siting question is its eventual effect on CERN itself. Because CERN is not one of the possible sites (geologically the ground is not stable enough, and space in the area is limited) there has been some concern that the new 300-Bev—wherever it is put—will draw scientists away from CERN, forcing the laboratory into the position of becoming a second-rate research facility.

Washington

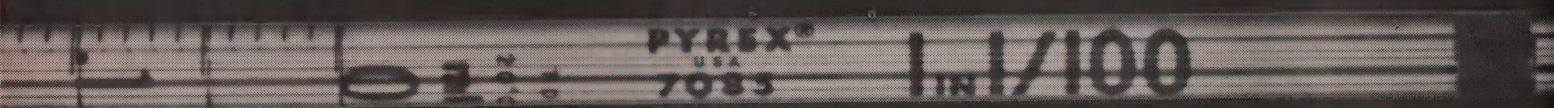
SCIENTISTS' SALARIES UP \$1,000 OVER TWO YEARS AGO

Median salaries of scientists during 1966 were \$1,000 higher than two years earlier, standing at \$12,000, according to the National Science Foundation. Economists, statisticians and physicists earned the highest salaries last year—\$13,100, \$12,800 and \$12,500 respectively.

This information was revealed by the NSF's biennial inquiry for its National Register of Scientific



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& Technical Personnel. The last survey was in 1964. Some 243,000 scientists responded to the inquiry, of which 27% were chemists, 12% physicists and 12% biologists. Only 8% were women.

Self-employed scientists earned the highest salaries, the 1966 median being \$17,000. Next came those employed in business and industry and non-profit organizations (\$13,000) and those working as civilians in the federal government (\$12,100). Educational institution scientists reported a median salary of \$12,000. Lowest median salary was earned by those in agricultural sciences and linguistics (\$10,000).

Largest users of scientific talent were educational institutions, employing 36% of scientists in the National Register or 87,315. Industry and business employed 34% or 83,990, and 10% or 24,689 worked for the federal government.

Of the scientists reporting to the NSF inquiry, 39% were engaged in research—16% in basic research, 13% in applied research and 10% in management or administration of r-&d. Some 18% reported that teaching was their primary work. The others were engaged in production testing, inspection and other work.

Pittsburgh

FEDERAL FUNDING SOUGHT FOR 'EDUNET' INFORMATION SYSTEM

Early in February an ambitious plan to interlink U.S. and Canadian universities in an information time-shared computer network will be submitted to federal government science agencies.

The National Science Foundation, National Institutes of Health and other agencies will be asked for some \$500,000 to start a pilot version of "Edunet" (Education Network).

More than half the information transmitted over the network will be concerned with science, according to a project spokesman at the Pittsburgh, Pa., headquarters. Although the type of information to be transmitted is not yet known for certain, three possibilities are:

- a directory service, in which scientists could determine the name and address of other researchers in a given field;
- bibliographic service, listing publications in any area of research;
- actual transmission of abstracts from papers, followed by transmis-

sion of full articles.

The official told SCIENTIFIC RESEARCH that in the first instance the network will be used for dialogue between scientists and other users for mutual solution of their problems.

The project is the brain-child of the Interuniversity Communications Council (EDUCOM), a group of 60 U.S. and Canadian universities concerned with the application and exchange of information about science, technology and the education process.

The Edunet program envisages an eight-month startup period of a prototype system in which specifications and charges will be established. This will cost \$500,000. Then follows a year in which the network is set in motion on a narrow-band basis of digital and voice information at a cost of \$3 million. Finally, there will be another one-year period for testing and moving the network into high gear for image transmission, including television. This will cost \$5 million, said the spokesman.

The first step will consist of establishing system research laboratories at the U.S. West Coast, Midwest and East Coast—each with a time-sharing computer. These will handle information among universities in their respective areas and, in addition, there will be five switching points that will take care of universities too remote to use the three computers directly.

With expansion, Edunet will be available to any EDUCOM university or government agency. The official said that since the system's content has not yet been decided upon, the number of universities using it cannot be predicted.

"We would like to think," he said, "that the federal government will use Edunet as its chosen instrument to bring about the standardization of information exchange."

London

ROYAL SOCIETY URGES CLOSER EUROPEAN SCIENCE TIES

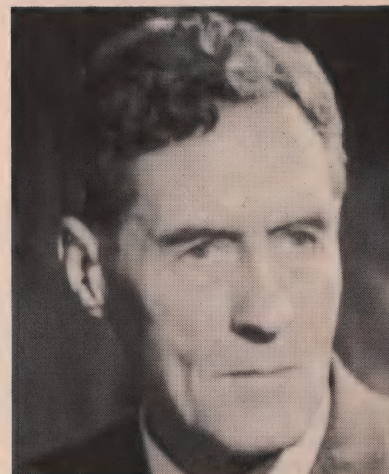
Britain's Royal Society has moved to promote closer cooperation within European science. Patrick M. S. Blackett, president of the Society, reported that an effort is being made to raise funds to "make a notable increase in the scientific interchanges within Europe by long and short visits and organization of conferences."

Already Society officials have visited their European counterparts

and money has been raised. In the past, he said, it had been assumed that relations between Britain and Western Europe would look after themselves and that no special efforts were needed to promote science contacts and interchange of scientists.

But a limited investigation of British university science departments showed that the number of postdoctoral students from Europe working in Britain is very small. Hence the cooperation program.

Blackett also revealed that the



Royal Society's Blackett: more European science cooperation

Royal Society is \$1.12 million short of the \$4.2 million needed to cover the cost of moving its headquarters next summer, and of running its affairs over the next seven years. He appealed to Fellows and companies in the science field to contribute to Society funds when Britain's present financial difficulties are over.

Blackett said the Royal Society wasn't the first owner of a building on the site of the new headquarters at Carlton House Terrace to run into money trouble. The cost of altering and improving a building there "nearly ruined" George IV when he was Prince of Wales early in the 19th Century. To recoup his losses he pulled the building down and built a row of houses, some of which the Royal Society is taking over after modernization.

New York

BIRTH PILL RESEARCHER SEEKS TO AMEND DRUG REGULATIONS

A research scientist whose work was ruled unacceptable by the Food & Drug Administration has mounted a campaign to change the 1962 Kefauver-Harris drug regula-

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tions.

Robert A. Wilson, M.D., of New York is seeking to amend the regulations section that prevents a sponsoring drug company or any researcher working with the sponsor's support from disseminating promotional material representing that the drug under investigation is safe or useful.

It was this section that made the FDA send its ruling to G. D. Searle & Co., rejecting research done by Wilson on the firm's Enovid birth control pill (SR Jan. '67, 13). The Administration ruled that Wilson was working for Searle and that his mention of norethynodrel (a hormone found only in Enovid) in a paper written for the *Journal of the American Geriatrics Society* was publicity for Enovid. He could do research or publicize the product, said the FDA, but not both at the same time.

Wilson told SCIENTIFIC RESEARCH that the regulations section states that its purpose is not to restrict exchange of scientific information concerning the drug, including dissemination of findings in scientific or lay communications media. Its sole intent is to restrict promotional claims of safety or effectiveness by the sponsor while the drug is under investigation.

Wilson said he has had a meeting with FDA officials to see what can be done to avoid this sort of trouble in the future for research scientists investigating the efficacy of drugs. He is gathering support from his professional colleagues and seeking the aid of Congressmen and Senators in Washington to amend the drug regulations.

Contrary to the FDA's opinion, Wilson maintains that a licensed investigator supported by a drug company is not employed by that company. The researcher may find highly unfavorable results from his study of a particular drug, he said, and should be at liberty to report those results in scientific journals. Wilson stressed that the FDA does not question the validity of his research.

Göttingen, W. Germany

FACULTY RETURNS PAY RAISE TO EASE UNIVERSITY CRISIS

The slowing of West Germany's "economic miracle" has brought a serious financial crisis to at least one German university. At Göttingen University, seat of atomic physics research during the Twenties and Thirties, the specter of

curtailment in teaching and research is very real.

In a dramatic gesture, a group of professors there pledged part of a recently-won salary increase to the university. The action served two purposes, according to one of the professors. It returned some of the funds to the university to meet its operations costs.

But more important, the professors believed, was the effort to alert the public to the university's financial straits. They hoped that by publicizing the problem, more funds from the state of Lower Saxony and the German federal government will be allocated to Göttingen.

The 167 professors, representing all eight faculties of the university, have now been joined by the students in the fight against dwindling funds. The students receive a monthly subsistence allowance from the university and the plan is to have them pledge some part of this allowance to the university library to enable it to modernize its collection.

Houston, Tex.

STAR, PLANETS NOW FORMING DISCOVERED BY TEXAS TEAM

A new stellar-planetary system now forming, lending weight to the theory that such systems originate with a concentration of hydrogen and dust, has been discovered by a Rice University scientist and his graduate assistant.

Frank J. Low, professor of space science at the Houston, Tex., university, and Bruce J. Smith, a graduate student, made the discovery in Arizona through infrared observations of R Monocerotis—the 12th magnitude star at the head of Hubble's variable nebula. R Monocerotis is a T Tauri variable, a young star thought to be in the early stages of formation.

Low terms his discovery a pre-planetary system—the birth of a star and its planets much like our solar system. Low used a low-temperature germanium bolometer of his own design in an infrared telescope at the Lunar & Planetary Laboratory of the University of Arizona, where he is also a research professor. His work is supported by the National Science Foundation and the National Aeronautics & Space Administration.

Low established that R Monocerotis is a star surrounded by a cloud of thick dust which absorbs and reradiates the energy produced by its luminous core. Low said: "The

high luminosity found is consistent with the idea that R Monocerotis is a protostar still undergoing contraction. If this is the case both the energy released in the contraction and a major part of the angular



Frank Low: discovered new star and planetary system forming

momentum are being transferred to an extended envelope of dust which will ultimately form a planetary system around the star."

He calculated the luminosity as almost a thousand times as bright as the sun. The dust concentration will flatten as it spins into a disk perpendicular to the axis of rotation. Particles will be attracted to each other, eventually building into planets.

Low's measurements show the dust may have graphite as a major component, the mass of the dust cloud being about a fourth that of our planetary system. Low and his associate have located at least ten other infrared stars since the original discovery, some of them having dust envelopes so thick that they emit no visible light at all.

Tokyo

PLANNING WELL UNDER WAY ON JAPANESE SCIENCE CITY

Japan is beginning to move ahead with its ambitious scheme to establish a "Science City" 100 miles north of Tokyo. Land will soon be bought for the project, which is designed to coordinate the entire Japanese government's research effort now diffused among several dozen separate unrelated laboratories.

The Science City Construction Agency has appropriated \$5.6 million in the current fiscal year and will appropriate a similar sum next year to build the 15½-sq-mile site at Tsukuba. It is estimated that

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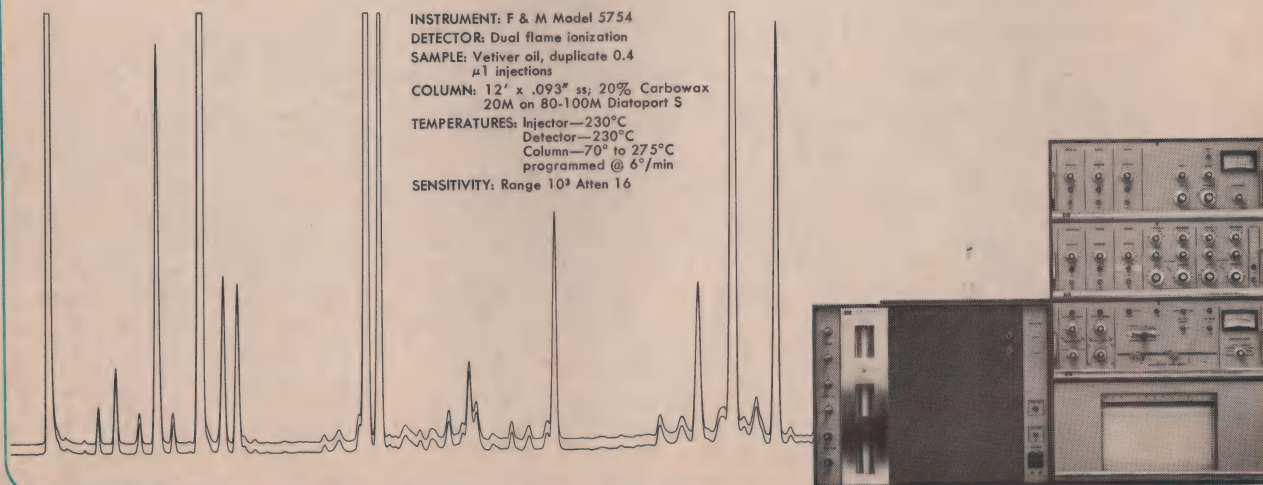
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the project will take ten years to complete and will cost \$1.25 billion.

Planners envisage that ultimately some 40 separate research organizations will be brought together. Some 10,000 scientists and engineers will be employed there, and their families and support personnel will swell the population to 160,000.

Because of the severe problems in acquiring real estate in land-scarce Japan, the agency has asked the Japan Housing Public Corp. to buy land and the latter authority is now negotiating with landowners. It has been authorized to spend up to \$24 million with land-purchase completed by March 1968, the landowners being paid in fiscal-68.

The Japanese government is not sure how much land it will be able to buy and will not reveal any ideas of how the city will look, for fear that the disclosure will invite resentment and suspicion from landowners in the area. Construction plans and cost estimates will not be prepared until the government has a more definite idea of how much land can be bought.

To gather ideas for establishing and operating a large research complex, a 10-man Japanese mission has been touring the U.S. and Europe. The government's Science & Technology Agency has started negotiating with individual groups that want to establish laboratories at the Science City. Government and private research labs are being invited.

Paris

EUROPEAN CHEMICAL INDUSTRY URGED TO JOIN WAR ON CANCER

René Truhaut, a leading French toxicologist, is little known outside French scientific circles. Yet his campaign to clean cancer-causing pollution from everything that man touches, eats and breathes has all the energy of a Ralph Nader war on unsafe automobiles.

Truhaut's chief campaign objectives are the chemical industry, source of food coloring ingredients, pills and anesthetics; and others such as pesticides and possible carcinogenic elements that workmen inhale or touch at the factory, fumes from domestic and industrial chimneys, and car exhausts.

Truhaut, a professor at the Faculté de Pharmacie and chemical research head at the Institut Gustave Roussy, both in Paris, told SCIENTIFIC RESEARCH that his initial efforts to line up support for his

work among the leaders of Europe's chemical industry are going well. He is president of the applied chemistry division of the International Union of Pure & Applied Chemistry at Basel, Switzerland, and representatives of Europe's chemical industry now serve on his executive committee. When his term of office ends late this year, one of the industry representatives may well replace him.

This, Truhaut believes, will help orient the industry to a position of force against proliferation of potential chemical cancer hazards—from a present position as their biggest promoter.

"In the long run," he said, "it is certainly in the industry's interests to develop liaison with toxicologists. The industry is in a good position to learn the risks of using some chemicals and it is therefore in the best position to enforce prevention of their proliferation."

New York

REPORT DUE OUT SOON ON NUCLEAR PHYSICS PREPRINTS

Is there a need for establishing a system of distributing preprints of technical journal articles among high energy nuclear physicists? The American Institute of Physics was, at the time of writing, due to have the answer by the end of December and to reveal its findings in a public report a month later.

After consideration of the report by an ad hoc advisory committee recommendations will be made on whether or not to set up a pilot, experimental system to see how it works in practice. The system would centralize distribution of preprints within theoretical high energy physics.

Although funded by the Atomic Energy Commission and paralleling the federal government's efforts to improve the scientific information dissemination system, the study was entirely on the initiative of the Institute.

Directed by Miles Libbey, the Institute's study group has gathered a wealth of information and opinions of theoretical scientists in the high energy area. A questionnaire was sent to every such physicist known to the Institute.

A preprint distribution system active for several years in the biochemistry study field, the Information Exchange Groups, is being dropped by its supporter, the National Institutes of Health (SR, Dec. '66, 15). Libbey told SCIENTIFIC

RESEARCH that the end of the IEGs has no bearing on the result of the physics study but the successes and failures of the biology system are being considered in detail.

Paris

FRANCE PUTS EMPHASIS ON TECHNOLOGY BUDGET

France is boosting its basic research spending this year but is giving budgetary emphasis to improved industry technology and a glamorous computer establishment.

The accent is on projects with promise of payoff, and unoriented basic research takes a decidedly secondary role. Nevertheless, the \$126.9-million 1967 budget of the Ministry of Education, performer of nearly all basic research in France, is up some 11% on 1966.

Christian Fouchet, Minister of Education, estimates that university laboratory budgets have risen from \$1.52 million in 1957 to an estimated \$34.7 million this year. The Ministry's research body, Centre National de la Recherche Scientifique (CNRS), will be spending \$92.2 million in 1967. Because of French accounting methods it is impossible to get an accurate picture of basic research spending in France. Applied research and even industrial development are often lumped together with pure science funds.

Only one private research agency—the Pasteur Institute—will get major state aid for basic research (SR, Nov. '66, 15). It will receive \$500,000 for research programs and \$1.6 million for new microbiology laboratories.

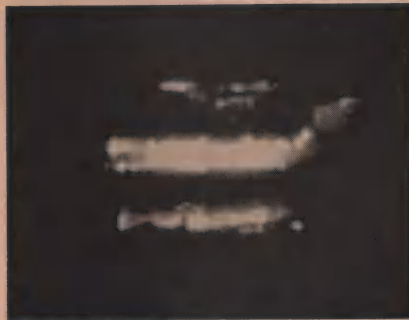
Washington

AAAS GROUP TO TOUR VIETNAM IN CHEMICAL WARFARE STUDY

A select committee of scientists drawn from the federal government, universities and private industry will visit Vietnam to examine the effects of chemical warfare weapons on the environment.

The committee will be appointed by the board of directors of the American Association for the Advancement of Science, probably in early March. Just when and how it will set about its work will be decided by the committee itself, according to Dael Wolfe, AAAS executive officer. In addition to the Vietnam study, the committee will also examine the wide-ranging effects of peacefully-used chemical and biological agents that pollute

HOW TO CUT THE "CHATTER" AND FREEZE THE FLASH.



Frames from FASTAX high-speed camera show flash during interruption of the circuit in low-voltage circuit breaker. Film was shot without illumination to accentuate flash.

Undesirable "chatter" or bounce can create problems in low-voltage circuit breakers. So can excessive flash or display given off during interruption of the circuit. But Allis-Chalmers solved these problems when they designed a new line of circuit breakers. How did they do it? With a FASTAX high speed motion picture camera.

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or change the environment. The committee will periodically report its findings.

"It has not yet been decided how many members the committee will have," Wolfe said, "but it will be a small group, yet an effective one. Of course, there is quite a possibility of the committee having difficulty getting to the forward areas in Vietnam."

The committee project stemmed from a proposal submitted by E.W. Pfeiffer, associate professor of zoology at the University of Montana. He told SCIENTIFIC RESEARCH that the committee will tour Vietnam, visit Fort Detrick—the U.S. Army's chemical and biological warfare research center at Frederick, Md.—and also visit U.S. universities where this type of research is being done.

Pfeiffer's original proposal, submitted through the AAAS Pacific Division, encompassed only the Vietnam study but the AAAS Council rewrote it at its annual meeting in Washington in December to include peaceful uses of biological and chemical agents.

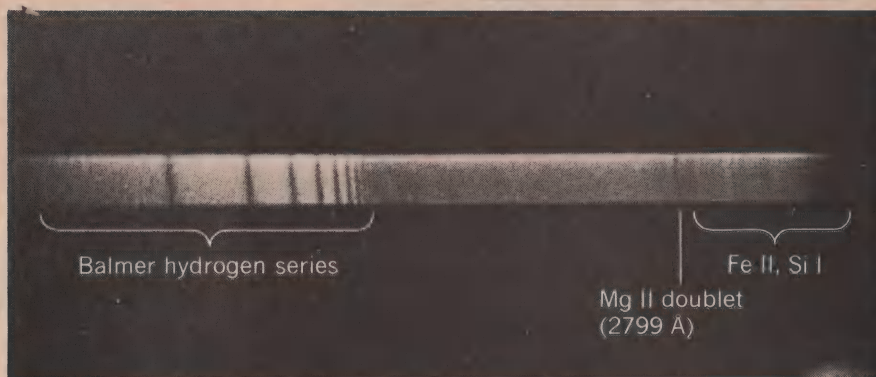
Washington

WARNING: LASERS MAY BE MEDICAL HAZARD, NOT HELP

While some scientists at the annual meeting of the AAAS were extolling the role of lasers in the new discipline of holography, a small group of physicians and physicists sounded the alarm on the medical dangers of laser irradiation in cancer treatment, surgery or other medical areas.

Citing a report issued to the U.S. Army Surgeon General, Edmund Klein at Roswell Park Memorial Institute in Buffalo and Samuel Fine at Northeastern University in Boston said that the dangers of using lasers clinically still far outweigh the advantages. Summarizing their results, they say that:

- tumor cells may survive laser irradiation and be scattered in viable particulate form at very high velocities. Therefore they could enter deeper tissue and accelerate the progression of malignant disease;
- laser irradiation can alter cell genetic characteristics;
- it can also splatter viable bacteria—possibly producing deep infections or septicemia;
- laser beams have injured the heart and lungs of large animals



Washington

GEMINI PHOTOS SHOW NEW REGION OF STELLAR SPECTRA

Astronomers have been given their first peek at the middle ultraviolet region of stellar spectra on photographs made by Gemini astronauts. Efforts to record these wavelengths (2,200—3,000 Å) on earth have long been foiled by the blanketing atmosphere.

Reporting the results at the Washington meeting of the AAAS, Karl G. Henize of Northwestern University said that the region contains the strongest spectral line yet observed of ionized magnesium

as well as an abundance of ionized iron and silicon.

The astronauts made the spectra during their extra vehicular activities aboard Gemini 10, 11 and 12 using a Maurer camera attached to the side of the spacecraft. With exposure times of up to 2 min, they photographed a total of more than 50 stellar spectra using both an objective grating to get moderate-dispersion spectra (184 Å/mm) and an objective prism of quartz to make low-dispersion spectra (1,400 Å/mm at 2,500 Å).

The most interesting grating spectra, Henize said, are those from Canopus and Sirius—two very hot stars that emit much of their radiation in the ultraviolet region. The Canopus spectrum shows a very strong Mg II resonance doublet at 2,799 Å—the strongest line of magnesium yet observed in stellar spectra—a weaker Mg I resonance line at 2,852 Å, the 2,882 Å line of Si I and several broad blended features identifiable as Fe I and Fe II. In the Sirius spectrum (shown above) the Mg II doublet is resolved into its two components. At least six other weak lines, which Henize tentatively identifies as lines of Fe II or Si I, are also visible.

In the prism spectra, which despite their low dispersion show good resolution, the hydrogen Balmer discontinuity is very prominent in spectral class A stars, the He I 2³S series limit at 2,609 Å is visible in early B stars and blended metal multiplets are visible in the 2,400-2,800 Å region of F stars.

Several anomalous stars also crop up on these pictures. Chief among these is the magnetic variable star Mu Leporis which shows a strong helium discontinuity which is normally associated with much hotter stars. Henize suggests that this may be caused by an extended atmosphere around the star.

and caused expansion and injury to the brain, eyes and other organs;

- laser irradiation may have delayed effects in the body including gangrene and auto-amputation of limbs.

The cancer report comes at a time when activities are peaking. At least six and probably closer to a dozen American medical teams are looking at the laser for cancer therapy; the list includes the National Cancer Institute which now has three large laser units in use on animals, but not yet on man. Most outspoken proponent of the laser-therapy concept is Leon Goldman, chairman of the dermatology department at the University of Cincinnati. He has used lasers to treat malignant melanoma and other tumors in man as well as benign skin diseases.

Based on the results, Fine and Klein called for serious consideration before clinical exploration of lasers is pursued. Alfred Ketchum of the National Cancer Institute and other panel members called for a long hard look at using lasers in anything except animal studies or terminal cancer cases. And certainly, the group concluded, much more research must be done before lasers are added to the medical armamentarium.

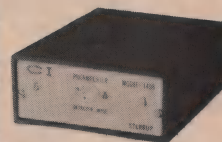
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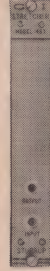
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ORBIT RADIO TELESCOPE, UNIVERSITY URGES NASA

An orbiting radio telescope six miles in diameter has been proposed by the University of Michigan to chart the unknown radio spectrum of the universe below 10 megacycles.

The National Aeronautics & Space Administration is now considering the \$100-million proposal and, at the time of writing, was due to make a decision in February whether to go ahead.

The radio telescope must be in space, rather than on earth, because the ionosphere disrupts incoming signals below 10 megacycles and at about 1 megacycle it blocks the signals completely.

The plan, designed by Radio-astronomy Department Head Fred T. Haddock, should enable the intensity of "several dozen" radio sources to be measured and the radio background to be mapped. A Saturn booster rocket will propel five satellites into a circular orbit 60,000 miles above the earth. The satellites would be arranged at the four corners of a rhomboid with one at the center, linked together by aeriels. The satellites would be positioned with microthrusters and the whole structure would rotate slowly.

The system would operate at 1 km wavelength, longer than the wavelength at which any other earth-based radio telescope operates. This supplies the name of the project—KWOT (Kilometer Wavelength Orbiting Telescope). This wavelength is used to identify the frequency band of 330 kilocycles to 3 megacycles. If NASA gives the "go" signal, the system should be orbiting somewhere about 1975 as one of the agency's principal projects after Apollo.

Haddock told SCIENTIFIC RESEARCH: "No one knows what the radio spectrum from 10 megacycles downward looks like. There must be a whole new list of radio objects that will show up. I am hopeful that this project will receive the go-ahead because 15 years ago no one thought much of the microwave frequencies in radioastronomy. Now three quarters of the work to do with quasars is at these frequencies. Although the KWOT will be designed for 10 megacycles it will be centered on 1 megacycle."

NASA has also received another proposal for an orbiting radio telescope—a 1,000-ft-long "knitting-needle" satellite circling 5,000 miles

from earth. The proposal has been submitted by Pennsylvania State University. The antenna would be instrumented to receive radio signals of 1, 3 and 9 megacycles, with a fourth channel of 27 megacycles for calibration, according to John P. Hagen, director of the Pennsylvania project.

Another approach to charting the radio spectrum, using earth-based antennas, was suggested by Bernard Oliver, former president of the Institute of Electrical & Electronics Engineers, at a recent meeting. He believed it is "out of the question" to build a vast orbiting radio telescope and that an array of smaller antennas on earth would give "superior performance to what the radio astronomer is used to." He proposed a system of thousands of 100-ft dia antennas in an array of six miles dia.

Chicago

ARGONNE IS FIFTH GROUP IN SEARCH OF NEW ELEMENTS

Preparation of new elements beyond element 104, especially 114 and 126, is proposed for Argonne National Laboratory's variable-energy, high-current, heavy-ion cyclotron (HIVEC).

Argonne is seeking \$13 million from the U.S. Atomic Energy Commission to build the accelerator and associated laboratory facilities. This is a fifth group requesting funds from the AEC for transuranium element research. The others are Oak Ridge National Laboratory, Lawrence Radiation Laboratory, MIT, and the University of Rochester (SR, Nov. '66, 13).

The proposed Argonne machine will be a 170-in. cyclotron capable of accelerating heavy ions up to those of xenon, with energies up to 18 Mev per nucleon for argon.

Washington

U.S. DOCTORATES JUMP 83% IN DECADE; DOUBLE AGAIN BY '75

During the past decade the number of doctorates awarded in the U.S. has nearly doubled. In the next ten years, according to the U.S. Office of Education, the number will probably more than double again.

There were 8,903 doctoral degrees conferred in the 1955-56 school year, rising to 16,467 in 1964-65. Estimate for 1975-76 is 36,900. Over the past decade the physical sciences and education have attracted the most doctoral candidates, but engineering may take the

lead by 1975, the Office reported. By then the order of popularity is expected to be engineering, physical sciences, arts and humanities, education, social sciences and the biological sciences.

In 1955-56 physical sciences doctorates were awarded to 1,667 candidates and 1,025 biological sciences candidates received their Ph.D. By 1964-65 these figures had jumped to 2,829 and 1,928 respectively. In the 1975-76 school year the physical sciences doctorates should number 5,600 and biological sciences 3,820.

Some 162 institutions awarded doctorates ten years ago; last year there were 218 colleges and universities. Columbia University led in 1955-56 with 526 doctorates awarded, followed by Univ. of California (452) and Univ. of Wisconsin (349). Last year the same three were in the lead, but the order changed to Univ. of Calif. (1,048), Columbia (616), Wisconsin (531).

Oak Ridge, Tenn.

FUSION MACHINE TO USE SUPERCONDUCTING MAGNET

Oak Ridge National Laboratory is designing a new approach to thermonuclear fusion research with a machine called DCX-3, in which a 75-kilogauss superconducting magnet will be used.

The DCX-3, being developed by the thermonuclear division under the direction of A. H. Snell, requires a magnetic field configuration consisting of a combination of mirror and quadrupole fields. The six coils needed to generate these fields have a total of some 7 million ampere turns in their windings. Oak Ridge studies indicate the use of a stabilized superconductor operated with high current in fields up to 75 kilogauss. The cryogenic system design provides for a 2° K cryopumping surface in addition to cooling of the superconductor.

MORE ON STAMLER . . .

The federal government has moved to block a suit filed by Jeremiah B. Stamler, a Chicago heart research scientist, for a hearing on the constitutionality of the House Committee on Un-American Activities. The government asked the U.S. Circuit Court of Appeals to reconsider its decision to allow a three-judge panel to hear the suit (SR, Jan. '66, 17). Stamler refused to testify before the Committee 20 months ago on an alleged connection with the communist party.

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The 435 has a fixed 1- μ sec time constant, but it is by no means a stripped-down job. In all other respects, as a matter of fact, it offers performance capabilities that would be exemplary for amplifiers of three or four times the price (and size).

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Active-filter pulse shaping provides an optimum noise figure with minimum resolving time. The 435 is capable of producing output pulses of approximately Gaussian shape, with peak amplitude occurring at 1.4 μ sec for single clip and 1.0 μ sec for double clip.

Pole zero cancellation effectively eliminates pile-up problems after the first clip. As a result, the 435 has exceptionally good overload recovery. It will snap back from 1000X overload to within 2% of rated output in just 2.5 non-overloaded pulse widths.

The 435 has a number of additional engineering refinements worth noting. Constant-impedance attenuators, for one; they have the advantage of permitting a wide range

of gain change (192:1) with minimal crossover walk. Switch selection of single or double clipping, provision for polarity inversion, and a differential input for preamp cable noise cancellation are a few more worthwhile features.

There are others. Our Bulletin 4350 will give you complete specifications. Write us for a copy; or, better yet, call our Technical Information Center at (615) 482-1006. Ortec Incorporated, 111 Midland Road, Oak Ridge, Tenn. 37380.

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WASHINGTON SCIENCE OUTLOOK

50-YR STUDY SOUGHT ON ENVIRONMENTAL EFFECTS

Not satisfied with bold action by the federal government on water and air pollution and on environmental health, Sen. Edmund S. Muskie (D-Me.) is pushing for the establishment of a Senate select committee to help determine how science and technology might affect man's environment over the next 50 years. Muskie's subcommittee on intergovernmental relations held hearings in mid-December to establish the fact that there is a serious lack of understanding on the part of government officials and the public on the factors which affect life.

Priority items for the committee would be urban housing, transportation, air and water pollution, pesticides, radiation, and other environmental problems.

Muskie, who has been holding hearings on technological impact on man for four years, is gaining support from his Senate colleagues. He plans to hold more hearings beginning this month with the intent of building "knowledge banks" in various environmental areas.

REVELLE ALSO PUSHING FOR THE LONGER VIEW

Roger Revelle, professor of population policy at Harvard University, also seeks to promote a longer view for government. Revelle testified at Muskie's December hearings that the federal government has too long planned around a four-year cycle, heavily oriented toward Presidential elections. He urged that Congress start thinking about the year 2000 and beyond, and the effects of today's technology on the environment when the world population will have doubled. He cited two basic technological changes which, he said, would essentially eliminate metropolitan air pollution by 2000 "if we had the capital, the courage, and the skill" to make them: 1. Substitution of automobiles powered by electric batteries or fuel cells, and 2. Generation of electric power near coal mines.

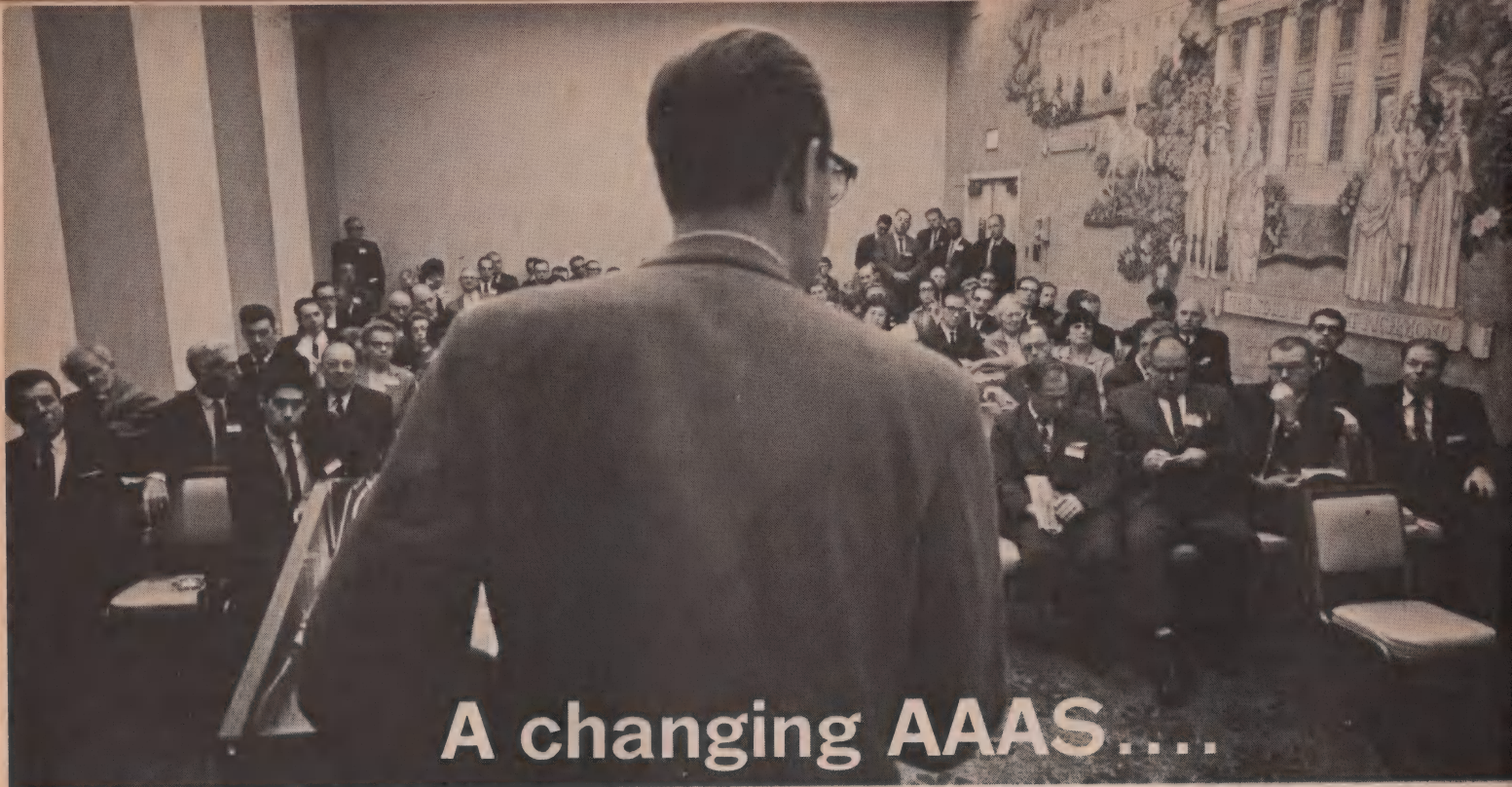
CONGRESS TO SCAN NEW LAB-ANIMAL RULES

Congress this month must pass on proposed animal-care regulations slated to go into effect Feb. 24. It must also consider spending \$2 million to enforce them. The regulations, resulting from what veteran observers described as the biggest flood of mail in memory, create a policing system under Earl M. Jones D.V.M., head of a new laboratory-animal staff in the Agricultural Research Service, to insure "humane" treatment for dogs, cats, monkeys, guinea pigs, hamsters, and rabbits used in biomedical research. Rules give details of housing, feeding, watering, sanitation, ventilation, shelter, species separation, and veterinary care.

Animal welfare groups indicate that they will continue to push for control over animals during laboratory experiments. The present law exempts animal treatment from control during the course of experiments.

FDA SEEKS CONTROL OVER MEDICAL DEVICES

The Food & Drug Commission is concerned over the safety and efficacy of health-aid devices ranging from hot-water bottles to lasers and artificial organs. FDA Commissioner James L. Goddard has indicated that legislation would be requested assigning his agency pre-marketing control over medical instruments. Currently, FDA can only act after a device has been shown harmful. Goddard cited a new soft-plastic contact lens and the artificial heart as devices that should be studied.



A changing AAAS....

SOME 1,750 PAPERS in 320 technical sessions were presented at the American Assn. for the Advancement of Science meeting in Washington Dec. 26-31. Here F. Peter Woodford of Rockefeller Univ. addresses a session.

....in a changing



Berl

Taylor

Thornhill

CHANGING OF THE GUARD IN AAAS was underlined at its 133d meeting with the retirement of Raymond L. Taylor who for the last time arranged the annual meeting. Walter G. Berl will take over scientific aspects, and D.W. Thornhill the organizational side of the task. Alfred S. Romer becomes board chairman, and Gerald Holton (with Barry Commoner who, ill, didn't attend) were elected to the board. Walter Orr Roberts was elected president-elect, and Don Price moved up to the presidency.



Romer

Price

Roberts



Holton



PLANNING CHANGES in AAAS is this committee (left), one of 80 scheduled business meetings. (Above) Some of the 7,282 registrants at the meeting look for old friends' whereabouts at the meeting.



Singer



Blamont

Moretti



Friedman

Abelson

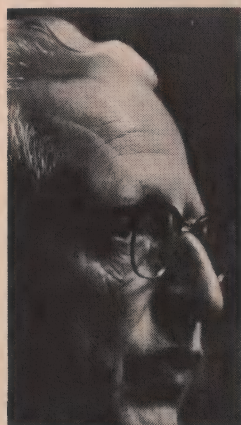
THE NEWEST ARMS OF ASTRONOMY — gamma-ray, x-ray and ultraviolet astronomy — continue to supplement and change astronomers' views of the universe as more rockets, satellites and balloons send back data. At sessions devoted to these above-atmosphere observations Karl Henize of Northwestern described the impressive ultraviolet stellar spectra made by the astronauts on the two most recent Gemini flights while Frank Wood from Flower and Cook Observatory, Nancy Roman from NASA and Sarah Lippincott from Swarthmore listened. Herbert Friedman of the Naval Research Laboratory (with Philip Abelson of *Science*) outlined his most recent x-ray results. From Europe Elena Moretti of Bologna Univ. discussed her search for x-ray sources with Jacques Blamont of France who has made ultraviolet balloon observations of the sun.

Wood

Roman

Henize

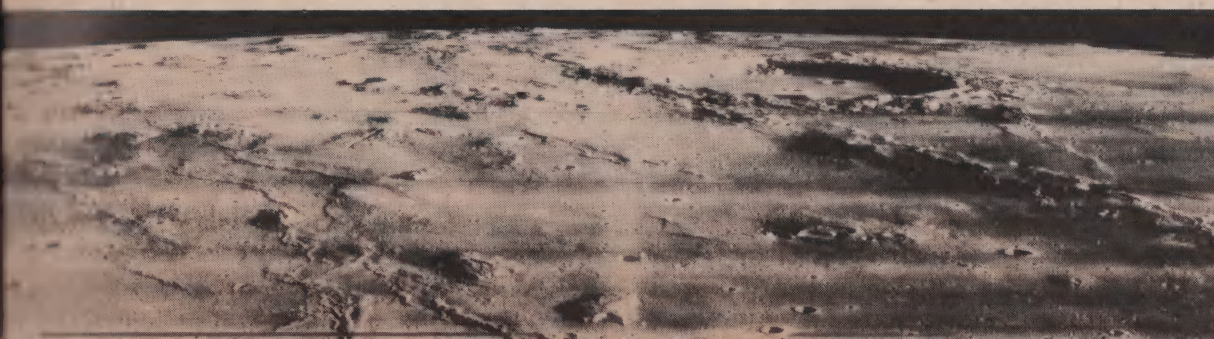
Lippincott



Menzel



CONTROVERSY OVER THE MOON'S ORIGIN highlighted sessions on the physics of the moon at which the latest pictures from U.S. and Russian probes were evaluated. Fred Singer of Miami Univ. (top left, caught pondering a question) offered a new capture theory for lunar origin, while others discussed vigorously how many of the moon's features were formed by volcanic action and how many by meteorite impact. Donald Menzel, Harvard Observatory director, moderated. The spectacular Lunar Orbiter II photo of the crater Marius provided much of the ammunition for discussion.



P. M. S. Blackett, president, Royal Society, London: "It is certainly not useful even to attempt to find direct material short-range justifications for pure research, which must essentially be curiosity-directed."



I. I. Rabi, Columbia Univ.: "Basic education is of supreme importance in giving us the knowledge to find a set of values that will help us . . . to understand our earth, its surroundings and the basic physiological and biological roots of mankind."



John Bardeen, Columbia Univ.: "As the amount of scientific and technical information continues to grow at a pace which makes the information unmanageable manually, mechanization appears to be the only solution to obtaining reliable, quality [patent] searches."



Melvin Kranzberg, Case Institute: "The great advances in both science and technology suggest that their aims, though different, are best served by a continuous dialectic between them."



Darrell Barnard, New York Univ.: "The real problem in science education is to teach young people critical thinking — to teach them how to learn — as an integral part of the curriculum."



Leith



Ham



Mead

CHANGING IDEAS OF RACE highlighted three sessions organized by Margaret Mead. Just what is race, the participants asked? Is it, as Theodosius Dobzhansky of Rockefeller Univ. maintains, both a category of

EXCITEMENT OVER THE LASER'S snowballing applications in science continues with uses that range from microscopy (above) to holography receiving special attention. Emmet Leith, Univ. of Michigan, reports that holography may become important in space astronomy where large, but light-weight, hologram plates can replace heavy lenses—eliminating the weight problem. But enthusiasm was tempered by reports from Edmund Klein, Roswell Park Memorial Institute, of severe damage to tissues from laser exposures, and from William Ham, Medical College of Virginia, of permanent eye damage from laser burns.

Klein



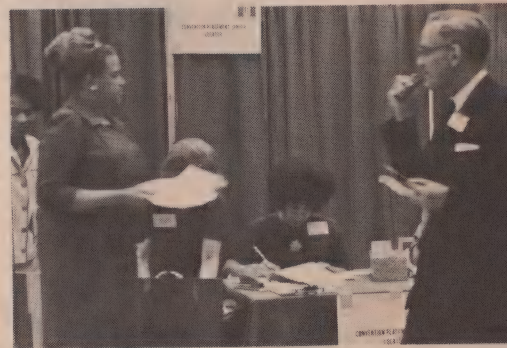
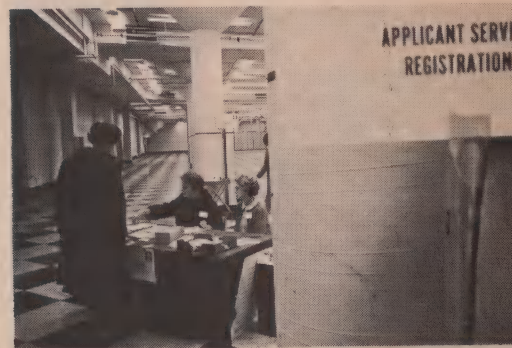
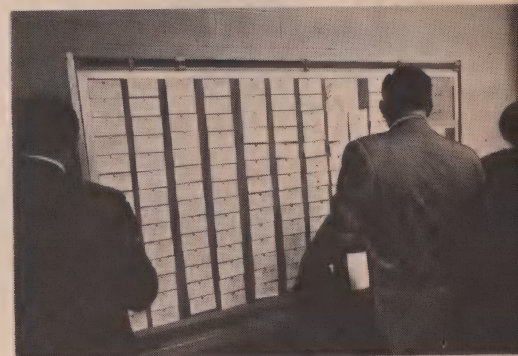
Fischelis

Kayan

Strauss



CHANGE TO METRIC SYSTEM in the U.S. was urged, to supplant the "absurdly old-fashioned" English system. Former Commerce Secretary Lewis L. Strauss, Carl F. Kayan of Columbia Univ., and Robert P. Fischelis, head of the Metric Assn., were among the proponents.

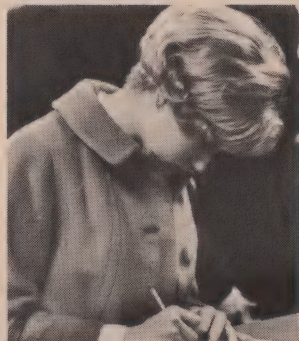
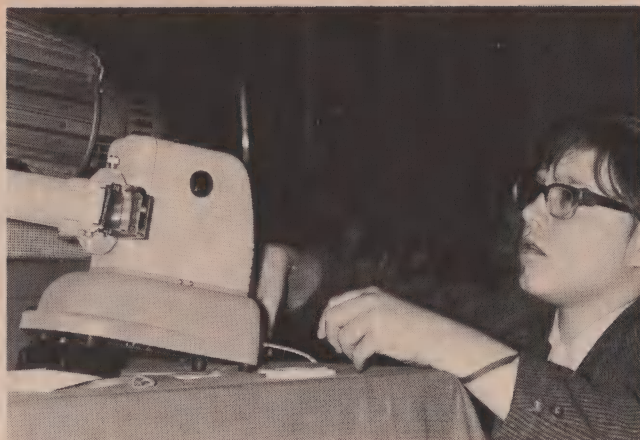


CHANGES IN JOBS: As at many technical meetings, recruiting was a sideline feature of the AAAS sessions. Openings for scientists were displayed on a bulletin board (above, top); persons interested in the positions registered with the applicant service staff (center), who arranged interviews.



Dobzhansky

classification and a biological phenomenon? Or, because race differences may just be compounds of individual differences affected by varying environments, should one disclaim races, speak only of "populations"?



CHANGING GENERATIONS: Scientists of tomorrow were well represented at the meeting, although not all gave as good an account of themselves as the young man who kept the slide projections on schedule at one session.

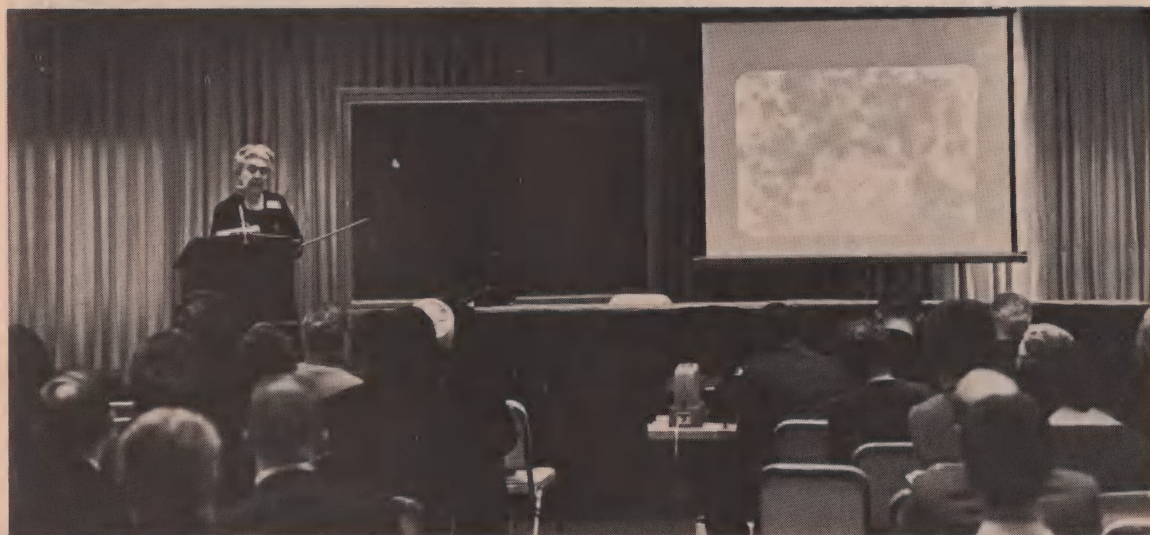


Hollomon



Brenner

AMONG TOP FEDERAL OFFICIALS attending the meeting were Asst. Commerce Secretary J. Herbert Hollomon, whose department won the 1966 AAAS Industrial Science Award, and Patents Commissioner Edward Brenner, who spoke to a symposium on new patent policy.



Diller

COMPLICATING CANCER RESEARCH and the already confounded picture drawn by Irene Diller (above) of how viruses induce certain well-known animal cancers, Eleanor Alexander-Jackson now finds evidence that the Rous cancer virus discovered in 1911, is not a virus after all, but a form of bacteria (see p. 34).

Philip Morrison, MIT: "The history of China could be estimated at 1015 man-years. So the whole history of man could be expressed in a few dozen 'chinas.'"



George I. Blanksten, Northwestern Univ.: "The scholar who sells his services to the government and therefore abandons the basic working conditions and regulations of his employer performs a disservice to both science and government."



John H. McNab, Esso Research & Engineering Co.: "We are going ahead with large-scale toxicological and nutritional tests on animals of proteins produced from oil hydrocarbons, and development of various food formulations. Design of manufacturing plant is now in hand."



James Rutherford, Harvard Univ.: "There is a great need for a humanistically oriented physics course in high schools—a course that will appeal to a wide variety of students from the science-oriented to the science-shy."



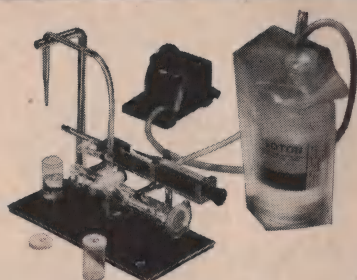
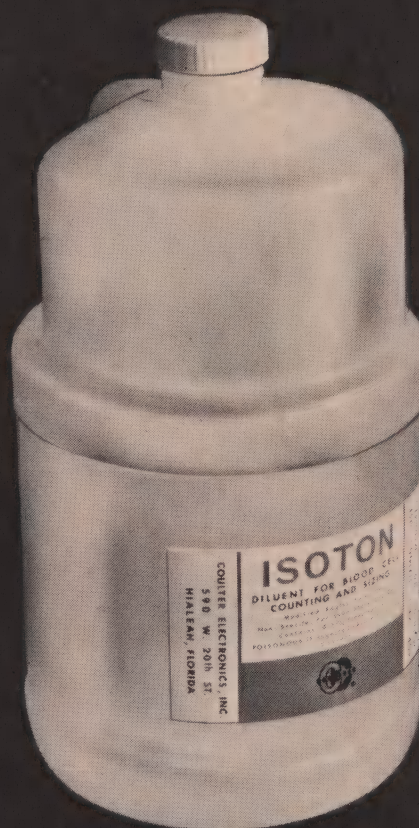
Dael Wolfe, AAAS executive officer: "Members thought it was a good meeting. Most controversial was the decision to give more AAAS emphasis to studies of what we are doing to our environment."

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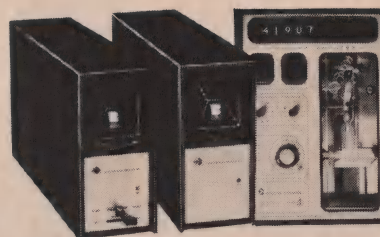
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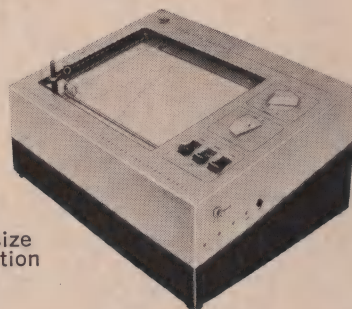
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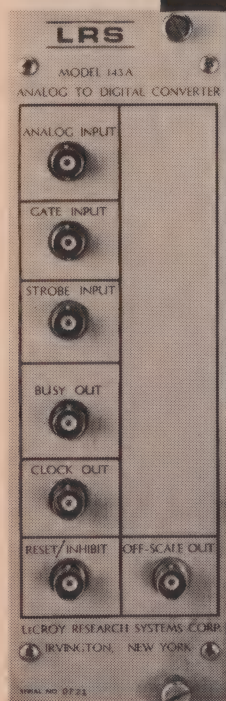
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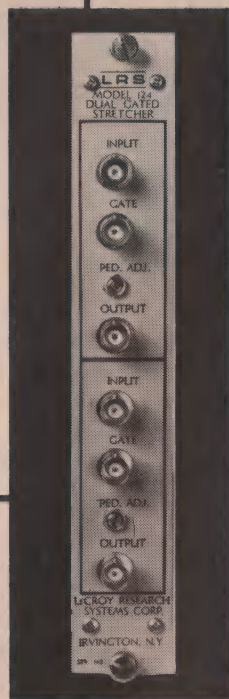
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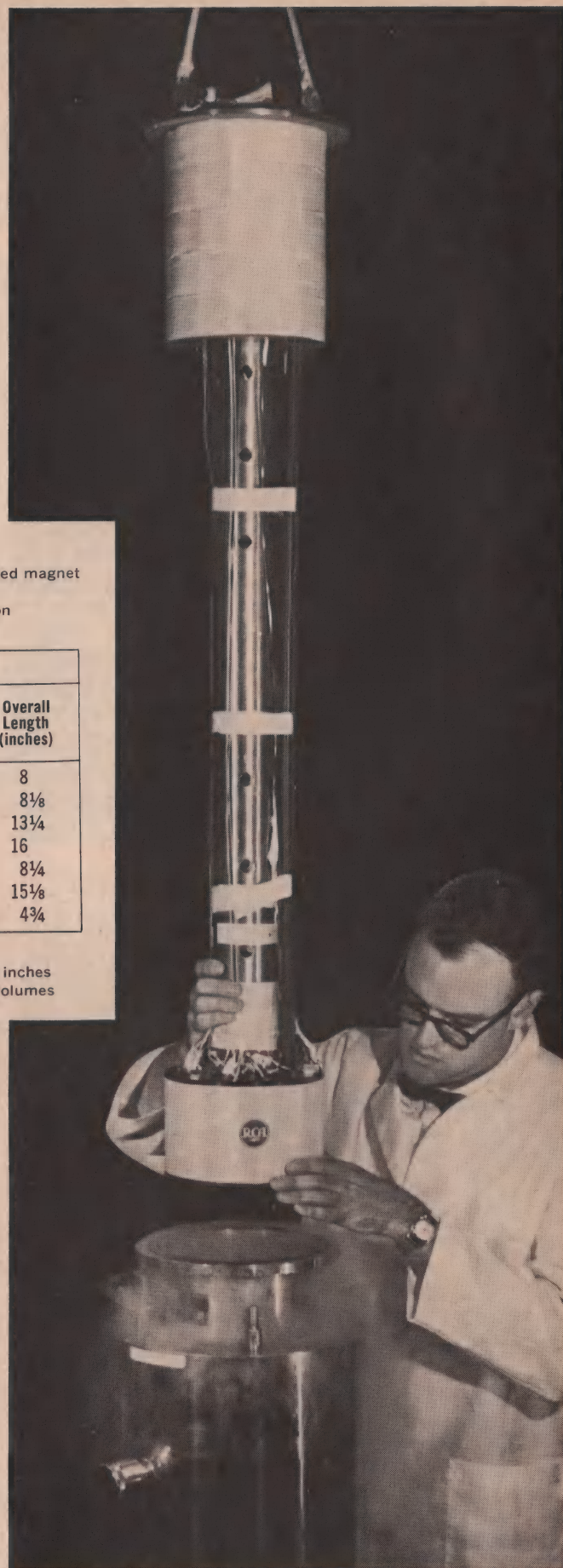
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The Rous cancer virus—really a bacterium?

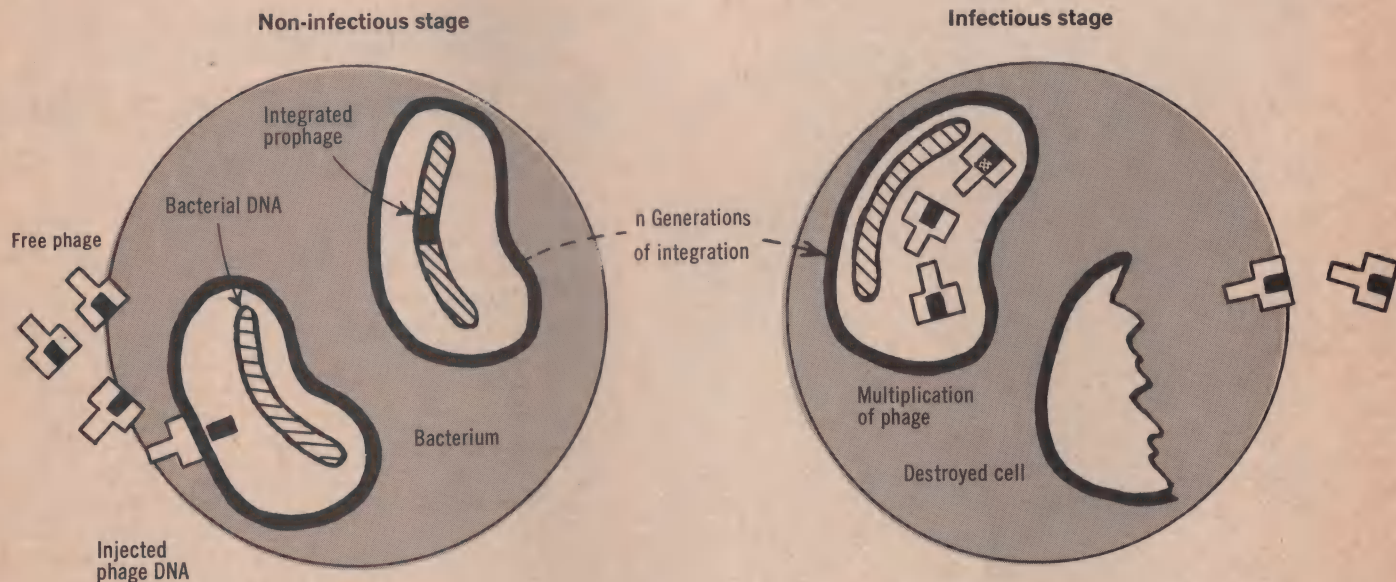
Bacteria can switch to a virus form — a look at “eccentric” genes, heredity and infection

by ROBERT BERNHARD, Assistant Editor

This past summer—just three months before Peyton Rous was awarded a Nobel Prize for his discovery of a chicken cancer virus—microbiologist Eleanor Alexander-Jackson published her hypothesis that the famed Rous virus is really only a “virus-like” form of an exotic type of bacteria, *mycoplasma*, the arch impostor of the microbial world! The author of this disharmony took up her subject afresh at the December meeting, in Washington, of the American Association for the Advancement of Science, where she described her several years’ research with the Rous virus and similar studies by colleagues which go back as far as 1953 (1-4).

Alexander-Jackson’s experiments covered a four-year period during which she repeatedly isolated mycoplasma-type bacteria from Rous virus cultures—taking great pains to avoid bacterial contamination—and showed that this isolate induces a Rous cancer-like disease in chickens. Her contention now is that there is significant evidence to support the view that the Rous virus is not a virus after all, but simply the virus-like and virus-size form of a pleiotrophic (having many forms) organism identified as belonging to the bacterial Order *Actinomycetales*. In its “normal” state this bacterial order has been known to simulate such different species of bacteria as micrococci, bacilli, and certain types of fungi.

Are all viruses simply transitional or alterna-



1 Heredity and infection. While it does not explain the extraordinary find of microbiologist Alexander-Jackson—that the Rous cancer virus is actually a virus-like form of a bacterium capable of assuming a number of identities—some insight is lent to the evolutionary relation between viruses and other organisms by considering the distinction between phage and prophage, the specific viruses infecting bacteria.

After “temperate” phage invade a bacterium they may take up a non-infectious state, known as prophage, in which they are associated with specific locations on the host chro-

mosomal gene-string, harmlessly reproducing in synchrony with the host. However prophage have the heredity potential of shifting back to the infectious state, multiplying, finally destroying the host, and diffusing out to infect other bacteria.

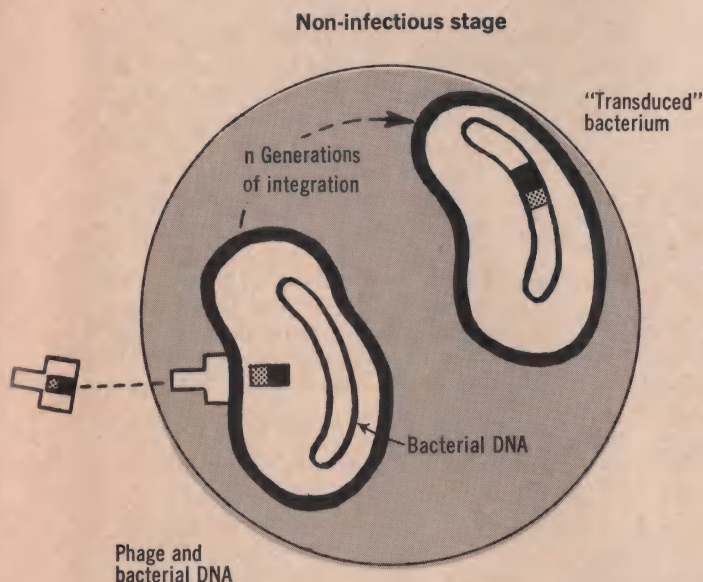
Strange as may seem this destructive relationship between bacteria and phage, it has evolutionary benefits because of the phenomenon of *transduction*—the alteration of the genetic makeup of a bacterium when a phage incorporates genetic particles of one host strain and transmits these genes to the newly infected strain. This exchange of genetic



Eleanor Alexander - Jackson.
Her several years work, finally showing the Rous cancer virus to be a bacterium, could overthrow the definition of viruses.

tive forms of other organisms? Do viruses constitute a separate category of life in the sense of a "species"—or do they originate "normally" from the normal constituents of cells? It is clear from experience with bacteria that these questions will not readily be settled—but it is clear also that the story of the virus will be clarified first when microbiologists finish the chapter on bacteria, the organisms which have no choice between propagating by heredity or infection, but are committed to both (see Fig. 1).

Eccentric creatures. Of all the major groups of living things, the bacteria in general—and mycoplasma particularly—are probably the strangest rabble, counting as their own some of the most eccentric creatures conceivable. As far as their taxonomy is concerned our knowledge of these microbes is in a much less developed state than that of the higher animals, plants and other microorganisms. Indeed there is still no widely accepted system for their classification, and the applicability of the "species" concept formulated for higher organisms is of doubtful validity.



material, purely by chance, achieves the same general result as sexual recombination in the higher organisms. This process is in dramatic contrast to the connection between heredity and infection in plants and animals, where there is no compromise possible between these two means of propagating heredity information. At some point the microbes departed in their evolution from the macroorganisms, taking up a danger-filled existence in which life hinges on the immediate present—either the phage becomes part of the bacterial genome, or destroys the bacterium.

At least five major bacterial groups are recognized by some microbiologists on the basis of morphology: the *eubacteria*, the *spirochetes*, the *gliding bacteria*, the *budding bacteria*, and the *mycoplasmas* (also known as *pleuropneumonia* or PPLO). A sixth, the *rikettsia*—which cause typhus and Q fever—are regarded by some as small bacteria, while to others they are large viruses!

The order to which Rous' "virus" has been assigned by Alexander-Jackson, the *Actinomyce-tales*, is actually a type of eubacteria—but a peculiar type which reverts to a mycoplasma or PPLO form by shedding its rigid cell wall and producing colonies of fungus-like cell communities surrounded by a single cell wall.

It is known that most species of bacteria found in nature are subject to infection by specific viruses, known as "phage", which arise usually from individuals of their own species. The relations between bacterium and phage are only partly intelligible but perhaps somewhere in their vexing snarl is the key to the humble house of the virus.

BACTERIA AND PHAGE

If all bacteria were susceptible to phage infection then phage would work their way through whole bacterial populations and then simply vegetate, their past or future beyond enquiry. But even for the most virulent phage there is in each bacterial species a resistant genotype. On the other hand, the "temperate" phage are more moderate, showing an intimate relation with their host which alternates between invasion followed by destruction of the host or the taking up of a tranquil intracellular residence in a non-infectious state, the *prophage* state.

Prophage divide more or less in synchrony with the bacterial chromosome and indeed the genetic material, DNA, of prophage is associated with a specific location on the bacterial chromosome and may be mapped as any other bacterial gene locus. However, each cell containing prophage carries the hereditary potential to produce infectious phage. Interestingly enough, the laboratory treatments under which a shift from the non-infectious prophage to the infectious phage condition can be initiated are the same treatments which cause gene mutation and chromosome breakage in most organisms, x-rays, strong reducing agents, and radiation whose wavelength is in the maximum absorption band of the pyrimidine bases of DNA.

By mutation prophage may become defective so that mature phage cannot be produced. Except for the fact that under experimental conditions the origin of a phage is known, and that it may regain its ability to produce infective virus by back mutation, such mutant viral genetic material is indistinguishable from host genetic material.

For this reason prophage can be viewed as a fragment of the host's genetic message, entirely capable of initiating its own multiplication. On

the basis of this, as well as other evidence to be discussed below, one can feasibly conjecture that phage, and possibly all viruses, may originate from the normal constituents of cells.

Heredity and infection. What would be the genetic and evolutionary function of this strange relationship between bacteria and phage—how could this eerily masochistic propensity of bacteria to produce phage benefit whole bacterial populations? Here again one is entirely on conjectural ground; even so the poverty of expression on this subject in recent years is surprising. But one coherent scheme drawn up by the noted British geneticist, Darlington (5), nearly eight years ago could not possibly be more timely at this moment.

Darlington's plan rests on the phenomenon of bacterial *transduction* (see Fig. 1) frequently observed in *Salmonella* and *Escherichia*. In these bacteria the phage produced by one strain can infect another strain, *changing the genetic makeup of the infected strain*. This change, known as transduction, occurs because phage occasionally incorporate genetic particles of one host strain and transmit these bacterial genes to the newly infected bacterial strain.

From what is known, if the phage genetic material which comes to the bacterium by infection

fails to be integrated in the gene-strings of the bacterium then phage may multiply on their own, to be propagated by infection, destroying the host cell in the chemical mayhem which this processes induces. However if the phage genetic material is successfully integrated, then it will propagate along the lines of the hereditary mechanism within a bacterial population. Therefore the bacteria accomplish the same general result as is achieved by sexual recombination (mixing of genes by pairing of different mating types)—the exchange of genetic material responsible for an adaptive and balanced polymorphism.

This process is in dramatic contrast to the connection between heredity and infection in higher plants and animals; in these there is no compromise between the two means of propagation of hereditary information. Somehow in the clamor of evolution the microorganisms listened to a different voice, parted from the macroorganisms, and took up a precarious way of life entirely dependent on the immediate present—purely by chance the phage either destroys the bacterium or becomes a part of its heredity.

PROVIRUSES

A relationship strikingly similar to the one

BIOLOGY'S ELEMENTARY PARTICLES — A PROLIFERATION?

The possibility that the Rous cancer virus is not a virus after all, but is one form of a bacteria capable of assuming many forms is more than a simple reminder that our understanding of bacteria and viruses is relatively shallow. Heredity, development and infection, the classical channels through which biologists pursue research, are convenient, but not ultimate, descriptives. There are several fundamental genetic agents—related to cellular function—which are molecular in scale, have a capacity for self-propagation, and which may exist in a domain where distinction between heredity, development and infection break down. Some of them seem able, like the elementary particles of physics, to disappear, reappear, and transform from one to another. What are these fundamental particles and how many are there?

Nuclear genes. These are the well-known elaborate combinations of protein and the nucleic acids (DNA or RNA). They are highly organized structures found

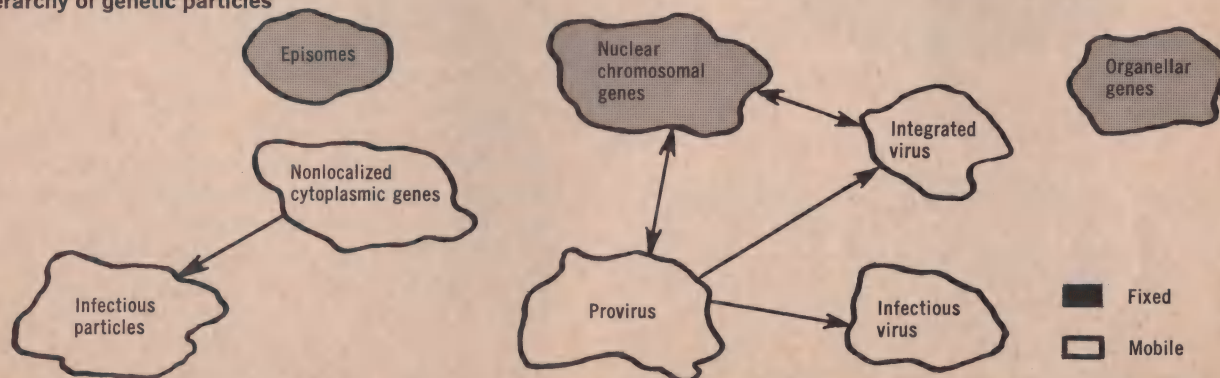
in the chromosomes of cell nuclei and the central core of the DNA or RNA viruses and bacteriophage.

Organellar genes. Certain genetic particles are attached to and marked by specific organelles (tiny organs) within the cell, localised in different ways according to the organism. The plastids (pigmented bodies mediating photosynthesis) of plants, Kappa particles (virus-like, lethal agents) and the gullet apparatus of *Paramecium*, and perhaps even the mitochondria (bodies mediating respiration in animal cells) are examples of this type of particle.

Diffusable agents, like the proviruses, are somewhat ambiguous particles which may exist in harmonious integration with the host cell, reproducing in synchrony with the host—but which may multiply and diffuse in an infectious state. They are transmissible by grafting, are not involved in cell differentiation, and prosper differently in different tissues.

Episomes. Similar to defective prophage (see text)

Hierarchy of genetic particles



between bacteria and phage-prophage exists between certain plants, a species of moth, and viruses. According to Darlington there are genetic particles, or *plasmagenes*, which play a normal part in the *cytoplasm* (the non-nuclear portion of the cell) of these larger organisms in nature but which have the capacity of multiplying and diffusing in an infectious state. Such particles in the integrated, non-infectious state he calls *proviruses*, to distinguish them from the well studied, infectious viruses.

Ambivalent particles. When plasmagenes spontaneously, or because of laboratory treatments, pull away from reproductive equilibrium with certain parent organisms they multiply and become infectious. In their range of effects such "rogue" particles mirror the behavior of well known viruses, some of which rapidly destroy their host while others—like the tulip virus—remain in equilibrium for many generations with their host.

In a number of moths polyhedral viruses arise without infection inside the caterpillar. In the silkworm they appear after the introduction of specific chemical compounds. In the tiger moth a change of nuclear genotype, by inbreeding, will lead to their appearance. The spontaneous virus

in their behavior are elements allowing bacteria to synthesize lethal proteins termed "bacteriocins." Episomes are capable of self-propagation either as integrated elements at chromosomal sites in synchrony with the bacterial host or in a vegetative state out of synchrony with chromosomal replication. The presence of episomes universally causes changes in the immunological constitution of the host bacteria; specific antigens mainly present on the cell wall are elicited by episomal stimulation.

Non-localized particles. There are particles which do not seem attached to known structures but are nonetheless fixed in the cell where they originated. They multiply evenly during development and pass through the egg (maternal inheritance) in heredity. The non-chromosomal determination of streptomycin resistance in the green alga *Chlamydomonas* is not associated with any known structure. Inheritance of non-chromosomal male sterility in maize shows maternal inheritance of unidentified cytoplasmic determinants. In the mold *Podospora* the nature of certain growing structures known as mycelia is controlled by a nonchromosomal maternal factor which can also propagate by infection.

Evolution, backward and forward. There is a significant distinction between genetic particles in the nucleus and in the cytoplasm. In the cytoplasm these particles can respond directly to changes in the environment, for the effect of their use or disuse is directly transmitted to offspring. When this occurs in microbes, where each cell division produces a new organism, there is the semblance of a Lamarckian principle in evolution—but it is evolution backward because the selection mechanism operates on what *was* an adaptive feature in a previous generation. This puts the role of the nuclear genes in a different light, for it marks the chromosomal genes for the process of forward adaptation.

in the moth *A. grossulariata* arises only in a particular recessive genotype, the Mendelian segregate known as *laticolor*. Having originated in *laticolor* the virus can infect moths which are not of this genotype.

When the cell contents of the King Edward potato are injected into other potato varieties a virus appears, producing symptoms in the others but not in King Edward. In the same fashion when cell contents of *B. maritima* seedlings are injected into plants of *Vigna sinensis* an infectious virus is generated. Similar results of grafting experiments are seen in Turnip Yellows, a plant disease carried by a virus.

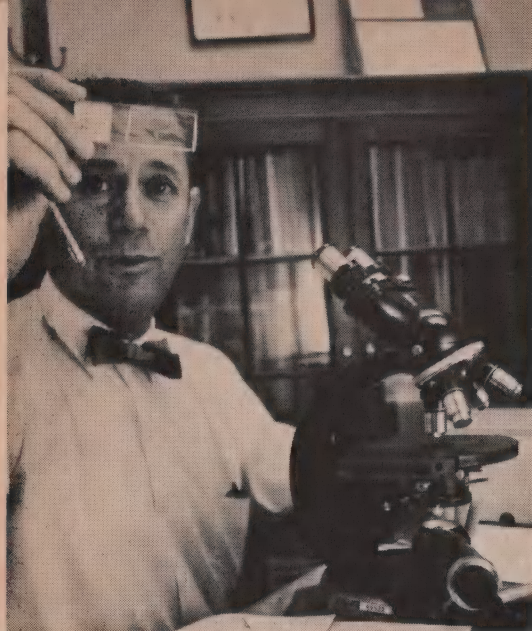
The pattern in all this, according to Darlington, is that the diseases carried by grafting are due to a plasmagene, a cytoplasmic particle capable of transforming under appropriate conditions into full-blown infectious viruses. The past history of these generated viruses is unknown, but it is assumed that they have a record of self propagation (as proviruses) in the parent organism in which they are not fatal, e.g., in *A. g. laticolor*. It must be supposed that the nuclear genes somehow act during development in *laticolor*—and similarly the *Vigna* nucleus acts on the *Beta* plasmagene—to effect the transformation to a virus state.

Evolutionary pattern. This distinction between provirus and virus, according to their mode of transmission—the first by heredity and the second by infection—is extremely important and lends some intelligibility to the evolutionary relationship between viruses and other organisms—although it does not readily explain the relation between the Rous virus and its bacterial form. Where the provirus is unbalanced in its propagation and destroys the host an adaptation towards infection is favored. Where the provirus is balanced in its propagation and benefits its host an adaptation towards heredity is favored. This contingency status is not likely to occur in plant or animal heredity, but in the unicellular organisms the contrast between infection and heredity partly breaks down and permits a choice.

Why does this contrast break down? Because genetic particles invading a cell can be excluded from heredity only if the organism is constituted of body cells and germ cells, i.e., if the organism has a differentiated life cycle. The distinction between body and germ cell all but disappears in microbial organisms, erasing any distinction between heredity and development; all the contents and features of the microorganism are passed on to the offspring.

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Paul Kotin: czar of the 'new toxicology'

Pathologist-Administrator Paul Kotin intends to conquer one of science's most difficult mountains.

Kotin's mountain is that awesome, mystery-enshrouded massif: environmental health. And the rugged path to conquest may be his "new toxicology"—the study of the basic, long-term, cumulative, multivariant effects of minute quantities of substances on human health. Cost of the first assault is \$25 million.

The pipe-smoking Kotin, 50, is a cancer-research specialist who cut his scientific teeth on California smog. He heads the new Division of Environmental Sciences of the National Institutes of Health, which in January opened the doors of a new 60,000-sq. ft. research facility leased in the North Carolina Research Triangle between Durham and Raleigh. He expects to have a staff of 1,000 when the Division's own laboratory—being built for it, also in the Research Triangle—opens in 1971.

Kotin's group will produce basic research information for the "big divisions" of the government concerned with environmental health—the national centers of Public Health Services' new Bureau of Disease Prevention & Environmental Control, several of the National Institutes of Health, and the Food & Drug Administration—as

well as other federal and state agencies, industries, and universities concerned with man and his relation to his environment.

"We're going to probe everything capable of modifying the cell, organ or organism . . . anything in the natural or man-made environment which can affect human health or evolution," Kotin told SCIENTIFIC RESEARCH, and ticked off pesticides, automobile exhaust, cigarettes, food additives and wrappings, polluted air and water as "the obvious, gross offenders."

SOME BURNING QUESTIONS

"It's the unobvious . . . the things which we only suspect or aren't aware of that need to be identified and watched," he said. "We don't even know whether they relate to disease, but we're going to find out.

"What are the effects of nanogram quantities of mercury or zinc or arsenic over a lifetime? What effect do they have in combination? How do they affect the metabolism of the cell, and where are the receptors in the cell which could be affected? What will these unknowns do to future generations of men—long after the possible benefits have been forgotten?"

Kotin's questions reflect the gen-

(continued on page 40)

U. S. Realigning Many-Pronged Attack on Environmental Quality

Americans are not content with the environment they themselves have created. They are obviously sick of, and from, breathing, drinking, eating and living in "an unpure world."

Major realignments within and across a number of federal agencies are being made to prepare for an all-out attack on the multi-headed hydra called, in new government parlance, "environmental quality control" (SR, July '66, 10). New environmental science divisions, departments and centers have sprung up in the National Science Foundation, the Dept. of Health, Education & Welfare and Dept. of the Interior. The broad new organizations of the Public Health Service, the National Institutes of Health, Food & Drug Administration and other branches reflect "the general enlightened philosophy and climate for environmental health."

A new major organ came into existence Jan. 1: the National Center for Air Pollution Control of PHS' new Bureau of Disease Pre-

vention & Environmental Control. Its first director is John T. Middleton, former director of the University of California's statewide Air Pollution Research Center. A national and international consultant on all aspects of air pollution, he has conducted his own research in photochemical effects of smog on plants. He replaced Vernon G. MacKenzie, longtime chief of NCAPC's predecessor body, PHS' Division of Air Pollution. MacKenzie moves up to be deputy director of the Bureau of Disease Prevention & Environmental Control under Richard A. Prindle.

Although many things have led to the new outlook, one of the major catalysts was the report on environmental pollution issued last fall by Rep. Emilio Q. Daddario's House Subcommittee on Science, Research & Development, which echoed the discontent:

"Our power to disturb or alter the ponderous forces and rhythms of nature by man-induced manipulations has increased to the point

where mistakes or unknown effects may be profound and irreversible." The report cited pesticides, nuclear waste, water and air pollution, and weather modification attempts as culprits in a massive conspiracy against life as we know it. It called for reorientation on the part of government and industry, including the establishment of an "early warning system" to watch for unwanted consequences of man's awe-inspiring technology.

One problem has been the lack of coordination on environmental problems. A House Government Operations Committee report uncovered the fact that the government has at least 192 laboratories in nine agencies involved in pollution research, all going their independent ways, obviously unaware of each other's existence.

Hearings by Sen. Edward Muskie (D-Me) are aimed at increasing knowledge in government and establishing a need for long-range planning in environmental problems (see p. 25).

Congress' czar on funds for science

When Project Mohole went down to defeat in the last session of Congress, the decisive blow was struck by the House Appropriations Subcommittee on Independent Offices, chaired by Rep. Joe L. Evins, the little-known Tennessee Democrat who refused to let Mohole live.

What is the Subcommittee on Independent Offices? What purse-strings does it hold on Federal science? And who is Joe L. Evins?

Taking the last question first (after noting that the Subcommittee must approve appropriations of the National Science Foundation, NASA, the National Aeronautics and Space Council and the President's Office of Science and Technology—among others) Evins can best be described as an exceedingly powerful man in Congress when it comes to the levels of federal spending for science.

And he considers himself a friend of science despite his guillotining of Mohole (please note, he insists, that his subcommittee reviewed nearly \$6 billion in r&d requests over the last few months, refusing only about \$100 million). "We did not slow down any research that is vital or important. We want to provide what is necessary for the country to move forward, and what slight trims there were were extremely selective."

Evins told SCIENTIFIC RESEARCH that his attitude contains "no disposition to impair or impede research" but he intends to look at all appropriations through the Vietnam mirror. "If we go into a further buildup over there, we will take a second look at possible reductions in this funding," he says. "If they settle things over there, well, then, there will always be more interest in doing things on the domestic scene."

SPREAD TOO THIN?

Although his subcommittee handles the budgets of the Veterans Administration and several regulatory, as well as research, agencies, Evins denies that it is overworked or spread too thin. "Some people (who would like to see separate subcommittees for the regulatory and research agencies) might think so," Evins acknowledges, "but I am not overwhelmed by this subcommittee. . . . We have grown familiar with this work over the years."

Evins admits that his bias is toward regulatory and veterans affairs but he briskly refuses to con-



Evins of Tennessee: Friend, foe or neutral?

sider giving up his subcommittee's science authority. "I don't think you will find that science has been impeded, jeopardized or impaired by our subcommittee," he declares. "Science will continue to move forward."

Nevertheless, it is clear that he has shocked many in the Executive Branch concerned with the health and wealth of science and it is not difficult to find among them many who are bitter and distrustful. In a word, they cannot see him—even murkily—as a champion of science.

Rather, he is seen as a capable, hardworking and guardian-of-my-prerogatives chairman who is simply not highly informed on science, despite 15 years service with the subcommittee, and whose main interests lie elsewhere.

For instance, his opposition to Mohole was partially based on the notion that it was strictly an oceanographic project duplicating other oceanographic research. During hearings on Mohole last spring, he asked: "Have not the big oil companies been able to just about find out this information?"

He also has a bias for small towns (population of his hometown, Smithville, Tenn.: 2,000) and against metropolitan centers.

In a way, Evins is following a "tough act" as subcommittee chairman: the late Albert Thomas of Texas, who established a reputation as a fast friend of science. Thomas frequently organized his questioning of a witness to help bring forth information which would aid the cause of his agency in defending his budget. "Thomas would often help an agency make its case before Congress," remarks an Administration budget official.

Evins has not shown this inclina-

tion. He frequently interrupts a hearing to moralize and, as many Congressmen are prone to do, often comes close to needling a witness unnecessarily. Once, he opened a hearing with a lengthy statement on the "high moral purpose" of the space program. But, when the questioning got around to atmospheric research rocket firings, Evins asked: "Do you think this \$10 million every year is wisely spent? You fired 6,000 rockets. What are we going to gain out of 7,000 that we haven't gained out of 6,000?"

Evins, 56, has been in the House since 1947. His eventual appointment to the Independent Offices Subcommittee came on the basis of his experience, before World War II, as a member of the legal staff of the Federal Trade Commission.

The Evins subcommittee is 100 years old. It was formed in 1866 as the Sundry Civil Subcommittee, handling miscellaneous agencies which didn't fit anywhere else.

It was not until 1917 that the subcommittee first got into science, taking jurisdiction over the National Advisory Committee for Aeronautics (now NASA). This past summer its science jurisdiction was challenged by a recommendation of the Joint Committee on Organization of Congress: consolidate authority for research appropriations into a single committee in each house of Congress.

This idea appears headed nowhere, however, and, lately, there has been talk of simply breaking up the Evins subcommittee into two—one for science budgets, the other for regulatory budgets.

One subcommittee member, John J. Rhodes, says, "There has been some thought toward taking NASA,

(continued on page 40)

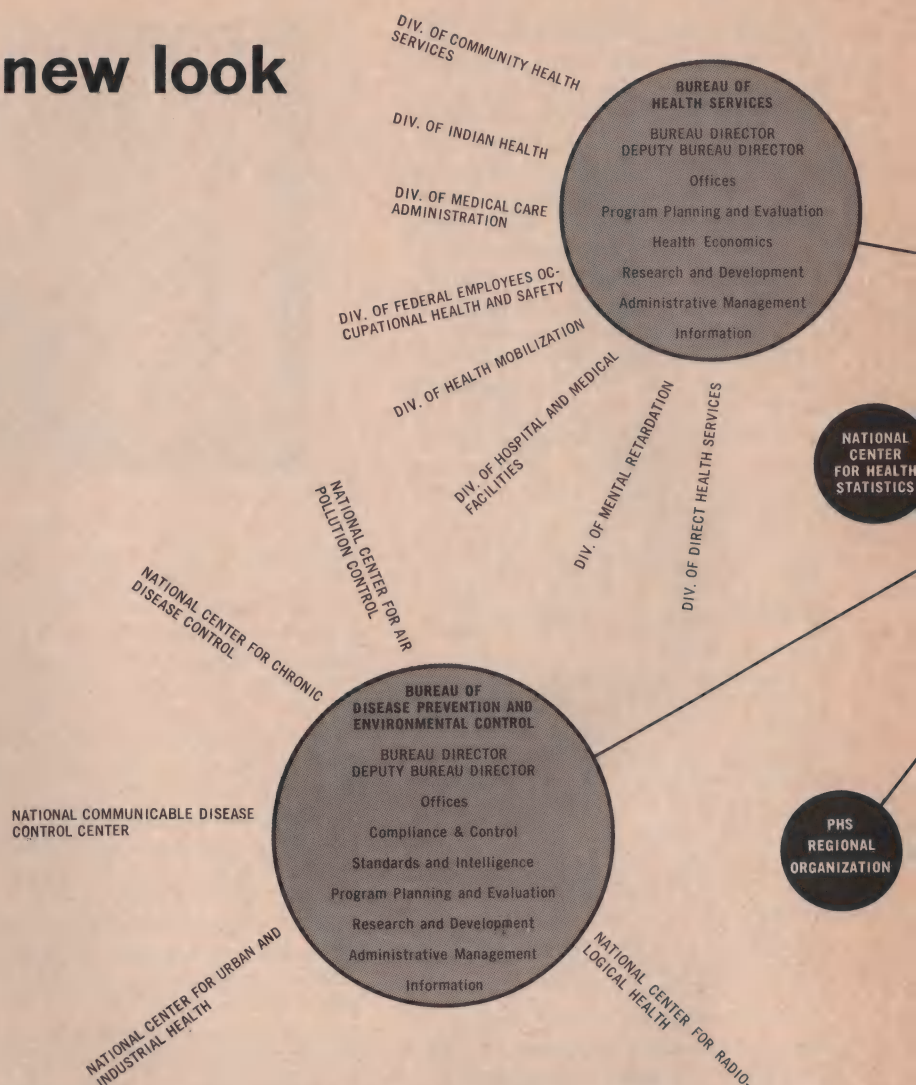
USPHS gets a new look

Reorganization of the Public Health Service in January calls attention to three major areas of concern to the Johnson Administration: training of medical manpower to staff America's expanding health programs, increasing the attack on mental illness, and correcting "environmental health" problems.

More money will be available for medical schools and training centers and for research on environmental and mental health problems but the granting mechanisms of the new PHS will not be greatly affected by the shake up. NIH's Division of Research Grants will continue to play the leading role in reviewing grant proposals.

The new PHS has five bureaus (see chart at right): a Bureau of Health Services; a Bureau of Disease Prevention and Environmental Control; a Bureau of Health Manpower; the National Institutes of Health (NIH); and the new National Institute of Mental Health (NIMH).

NIH also remains basically unchanged, except for the loss of NIMH and the addition of a new Division of Environmental Health Sciences, which is expected to concentrate on the long-range effects of residues in food, drugs, cosmetics fibers, etc.



CONGRESS' CZAR

(continued from page 39)

AEC, NSF and even some Defense Dept. research and putting it all under one subcommittee. That would be one way to stop some of this duplication in government research funding."

If the subcommittee is split into two, Evins would probably go with the portion which handles the regulatory agencies. But if nothing changes, as seems most likely through this new Congress, Evins will continue to sit in his powerful judgment seat on science.

This means some quick readjustments for agencies like NSF. As one official commented: "Everyone over here wishes we had paid more attention to Evins when he was number two on the subcommittee. We put everything on Thomas, including the style of drawing up our budgets. So today nobody knows much about Evins but one thing is sure—we will have to change a few things around here. . . ."

PAUL KOTIN

(continued from page 38)

eral public stir over environmental and occupational health—over the multitude of sins which have been laid at industry's doorstep. His new research group mirrors the federal government's new awareness.

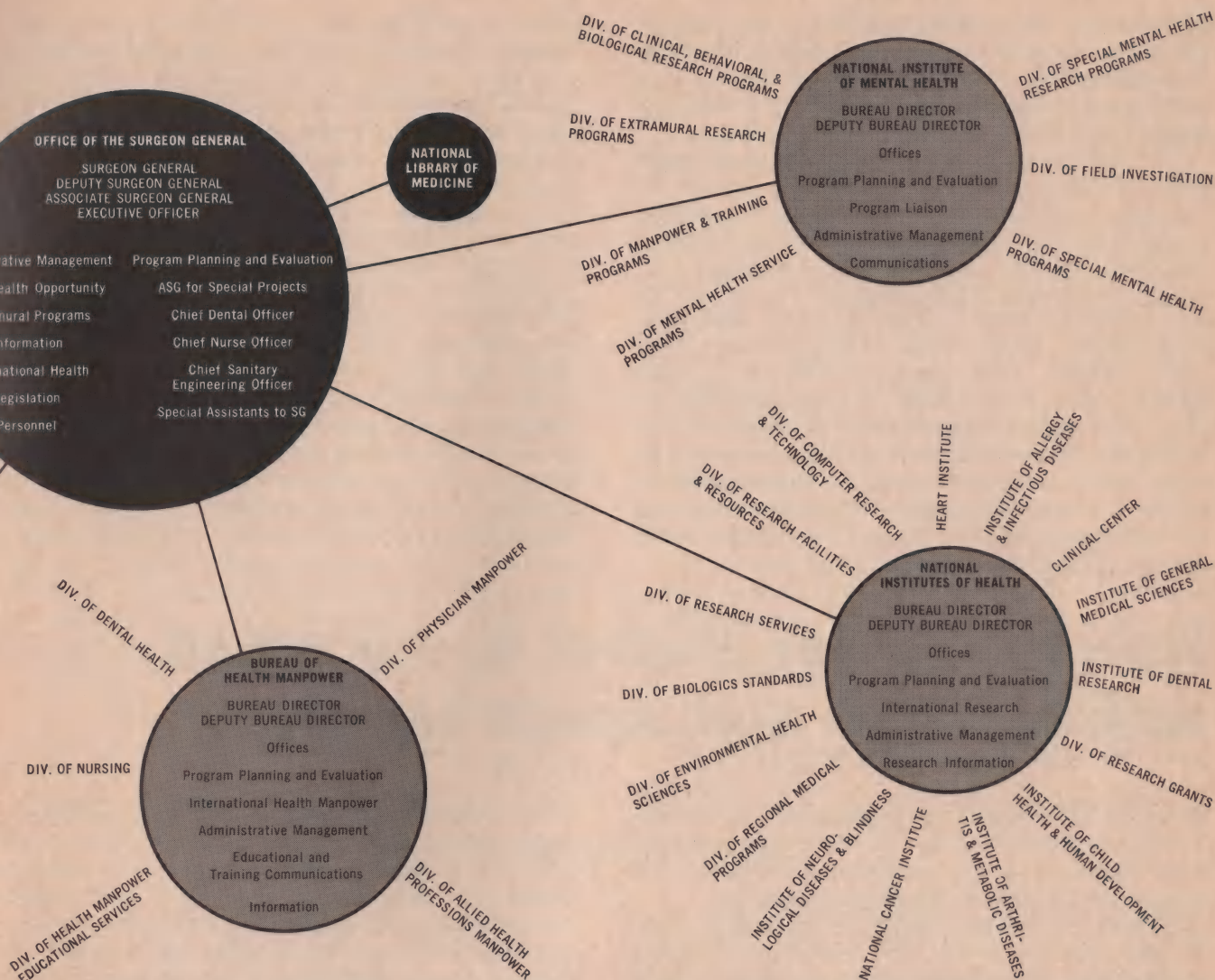
Far from a novice, Kotin has been probing disease cause-and-effect since high-school days in Chicago. He was grabbed for the directorship from the post of scientific director for etiology in the National Cancer Institute by Surgeon General William Stewart who last year cited Kotin for "superior service in education and research devoted to mechanisms of cancer causation and prevention." He served as an army doctor during World War II after receiving his M. D. from the University of Illinois. He taught and practiced medical pathology—specializing in cancer—at the University of Southern California for 13 years

before joining the Cancer Institute in Bethesda in 1962.

Despite his cancer orientation, Kotin wants to de-emphasize cancer-related studies "because of the great job being done in my old outfit [NCI's etiology group]."

Although the environmental contamination areas which are receiving the most public attention will come under Kotin's guns, the new division is attempting to break away from the standard method of studying the isolated system—the effects of one element in a closed biological system. Instead, Kotin said, the "new toxicology" emphasizes the check of multiple exposures of minute traces of materials on man, on the race as well as the individual. Major areas being eyed:

- **Pesticides**, which will be looked at from the molecular level to attempt to discover the mechanisms involved in long-term pesticide storage and breakdown in the



cell. Concern has spread from such discoveries as the fact that remote sea life in Antarctic waters contains trace amounts of DDT, in use for only 20 years.

- **Air pollutants**, especially hydrocarbons, which are of specific interest to Kotin's group, and lead, which has stirred gasoline manufacturers to reconsider using it as an additive. Although the division will leave the broad hydrocarbon-cancer studies to NIC, Kotin believes that basic subcellular work needs to be done relating hydrocarbons to other diseases.

- **Industrial and occupational hazards** and those in "high-risk" environments. Asbestosis poisoning and silicosis among miners illustrate the macro-molecular substances which have been identified in scores of crippling diseases which the division will help identify. Particular factors such as lead poisoning from cheap paints used in slum housing have already

been identified. Scores more are suspect.

- **Food, drugs, cosmetics and packaging materials**, of particular concern to FDA and the commodities industries, will be looked at more closely on the basic, long-term biological and genetic levels.

- **Water pollutants** that are not now being considered by pollution agencies or health officials will be rounded up under proposed population studies.

- **Radiation**, which is being investigated by a number of agencies, will be studied in relation to its effects on contaminants in man in his environment.

More basically, however, the new unit will devote itself to studying "unobvious hazards." For example, trace metals like zinc, mercury and tin are being studied by several university teams as causative agents in diseases ranging from cancer to arthritis. The division will continue these studies

and award new contracts to institutions and laboratories interested in these elements.

High on the priority list is the establishment of general principles or guidelines to help the government get "indices of harmfulness" on tolerance and levels of storage of elements, as well as base lines for element interaction and cumulative effects of elements.

The division is working with \$25 million this year, of which the greatest portion will go to extramural research done under contract by universities, industries and other agencies. Kotin emphasizes the extramural program, which is working through an office at the NIH Bethesda "campus," as the major strength of the division. But he believes his real mandate is the organization and direction of environmental health research and the collection and dissemination of results quickly and efficiently.

ELECTRON SPIN resonance (ESR) spectroscopy, once restricted to the laboratories of physicists meditating over crystal structures, now is being used in an increasing number and variety of applications in chemistry and biology.

This technique, which permits precise measurement of the location and energy states of the unpaired electrons in atomic or molecular systems, is specifically suited for teasing information about chemical bonding and energy transport out of complex systems in which the unpaired electrons are associated with unfilled electron shells—as in transition group atoms—or “delocalized” molecular orbitals. The ready availability of ESR spectrometers conveniently accompanies the recent intensification of interest of chemists and biologists in paramagnetic systems. These systems include transition metal complexes, organic radicals in solution, radicals interacting through ion pairing and solvation, enzyme systems which

given by $g\beta H/h$. This is the famous Larmor precession frequency (see box). At this frequency an unpaired electron in the lower energy state will absorb energy equal to $g\beta H$ and be excited to the upper energy state, i.e., the electron is like a gyromagnetic top in resonance with the electromagnetic field.

In a population of paired electrons the electron spin vanishes so that no energy absorption can occur. Only when the sample system contains a population of unpaired electrons does it reveal an absorption pattern. Since the exact conditions for resonance will vary from system to system, then from the known values of H and the precession frequency which are required to induce a resonance condition, it is possible to compute the g -factor which gives detailed insight into orbital states of the unpaired electrons, which in turn yields information on the type of chemical bonding in the system. From the total area under a

New molecular studies are pressed with electron spin spectroscopy

function as a result of a paramagnetic center, electron transport in cellular metabolism, cellular free radicals induced by ionizing radiation, carcinogenic compounds and pharmaceuticals.

Theory and method. Spectroscopy by ESR relies on the intrinsic spin, and resulting magnetic moment, of an unpaired electron, i.e., a single electron occupying an atomic or molecular orbital. Where these spins and magnetic moments take up random orientations of equal energy in the absence of external fields, the application of a magnetic field will cause the spins and moments to align themselves parallel or antiparallel to it. Since the quantum number of electron spin can only be either $+1/2$ or $-1/2$, the magnetic field “splits” the original ensemble of electrons in a sample into two distinct populations—a lower energy group in which the electrons are aligned parallel to the field and higher energy group of antiparallel electrons.

The difference between the energies of the two populations is $g\beta H$ (1), where g —the gyromagnetic ratio—reflects a blending of the electron's intrinsic spin and orbital angular momentum, H is the magnetic field intensity, and β translates spin momentum units into magnetic moment. The ESR procedure consists of effecting the energy separation or “splitting” described above, by the application of a magnetic field. At the same time the sample system is subjected to an electromagnetic field whose energy is $g\beta H$; since the energy of radiation of frequency is simply h , then the applied electromagnetic radiation has a frequency

single resonance absorption line it is possible to calculate the total number of unpaired electrons. The width of a spectral line gives information about the structure of the lattice surrounding the electron, since spin-lattice interaction (energy exchanges) have a “quenching” effect on the lifetime of the excited state of an electron. Further and more detailed information on the chemical environment of an atom may be derived from the fact that a single spectral line suffers characteristic splitting because of interactions of the unpaired electron with the magnetic moments of neighboring nuclei and other electrons (spin-spin splitting, or *hyperfine structure*),

In practice ESR spectrometers operate with rather large values of H (from 3,000 to 12,000 Gauss) and applied electromagnetic radiation whose wavelengths are in the radar X band (3 cm) and Q band (8 mm). Although it is possible theoretically to operate at more modest levels it is most desirable, in order to maximize the resonance absorption intensity, to work in these microwave regions. The reasoning here is that, because of the Boltzmann factor in the electron population distribution, the two electron energy levels can never contain equal numbers of electrons; there will always be fewer in the upper level. Indeed it is precisely this continuing density differential which makes it at all possible to produce an absorption spectrum. Therefore, in order to maximize the absorption of energy from the electromagnetic field it is necessary to maximize the difference in electron population between the two

energy states; to accomplish this the splitting magnetic field should be as large as possible.

HYPERFINE STRUCTURE AND CHEMICAL BONDING

The magnitude of the splitting of the single electron resonance absorption line depends on the *molecular* orbitals in which the electron moves. Since molecular orbitals reflect molecular energy structures, the energy and orientation of these orbitals can frequently be inferred from the hyperfine splitting effects briefly noted above. The manner in which the magnitude of this effect varies with different angles of incidence of the electromagnetic radiation is useful in making semiempirical evaluations of the pi and sigma bonding in a molecule. Here additional information can be had from the "super" fine structure due to perturbation effects from neighboring atoms (Fig. 2). The detailed theory of hyperfine splitting can be found in Pake's classic monograph (1), and the methodology of interpreting chemical bondings from fine structure is discussed in the original work of Griffiths, *et al* (3), with ammonium chloroiridate.

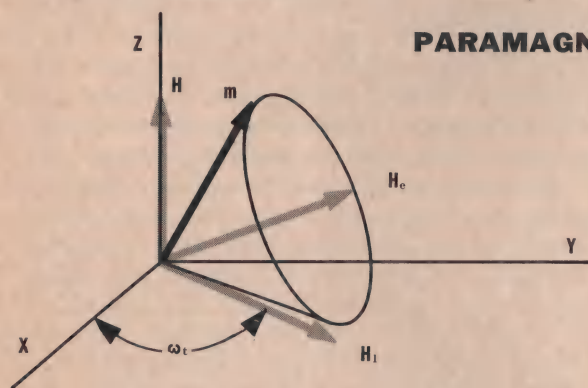
Non-metallic radicals. Semi-empirical calculation of sigma and pi parameters for a number of organic radicals containing non-metallic elements occupies a considerable number of investigators.

Among the first to attempt such evaluations, Barton and Fraenkel (4) reported such calculations for a series of cation radicals including dihydropyrazine and its methyl-substituted derivatives. More recently the same type of investigation has been made on anion radicals of azines (5).

Nonequivalent ortho and nonequivalent meta hyperfine structure in the nitrosobenzene anion radical has been interpreted as the result of nonlinearity of the C—N—O group on the benzene ring (6). Here the possibility has been noted that the frequency difference between the two nonequivalent protons is greater than the rotation frequency about the C—N bond, indicating that ESR studies can also be used to place upper and lower bounds on bond rotation speed. The molecular distortions required to accomplish chemical reactions frequently are seriously affected by the ease with which rotations about a chemical bond may occur.

An interesting example of how ESR probing may elucidate the intermediates of a chemical reaction is seen in the recent work of Britt and Kaiser (7), who showed that in the alkali metal reduction of triphenylphosphine the anion radical formed is not derived from triphenylphosphine itself, but originates from diphenylphosphine.

Ion pairing and solvation. The hyperfine struc-



1 Precession of electron spin magnetic moment

A spinning electron is a little magnet, a gyromagnetic top. Although the electron's orbital motion also produces a magnetic moment, the contribution of this component to the paramagnetic susceptibility of a molecule is largely ineffective because the strong intramolecular electric fields tend to hold the orbital momentum vector in fixed orientations despite the perturbation due to external, magnetizing fields.

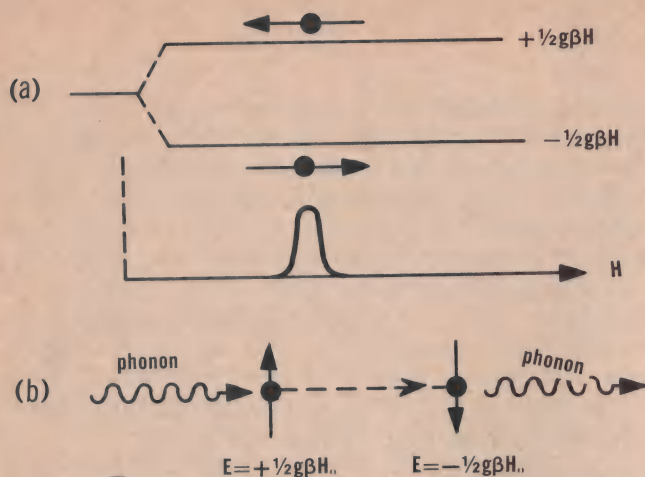
Consequently, the dominant features of the paramagnetic effect are due to intrinsic electron spin which is restricted to the quantized values $\pm\frac{1}{2}$. (It should be recalled that the magnetic field in a paramagnetic substance is greater than in a vacuum whereas in a diamagnetic medium it is less.) If all the electrons in a molecule are paired, i.e., if the population of spin $+\frac{1}{2}$ is equal to the population of spin $-\frac{1}{2}$, then the molecule's permanent moment vanishes.

PARAMAGNETIC RESONANCE

Therefore the measurement of a permanent moment tells us how many unpaired spins are in a molecular structure.

If an isolated electron top is placed in a magnetic field, H , then the electron's constant magnetic moment vector precesses at a fixed angle with respect to the direction of the applied field (Fig. 1), with a frequency known as the Larmor precession frequency, ω . Because spin is quantized this applied field "splits" an electron population into two discrete groups, one in which the Z component of spin is parallel to H and the other in which it is antiparallel. The energy difference between the two populations can be shown by quantum mechanical analysis to be just the Larmor frequency.

ESR experiments do not use a constant H , but employ a time-dependent field obtained by adding to the constant "splitting" component a small precessing field H_1 at right angles. Under these conditions the electron's magnetic moment, m , precesses about H_e , the effective magnetic field, producing the famous "coolie hat" surface. Now if the oscillating component is tuned to the Larmor frequency the effective field collapses to H_1 , since for every angle ωt by which the moment m moves out of the X-Z plane it will be pushed back into this plane by an equal amount by the precessing H_1 . That is, the motion of m is restricted to "flopping" back and forth between the $\pm Z$ directions. When this condition is met, the electron is in resonance with H , and will absorb or radiate energy equal to the difference between the two quantized spin states.



2 Electron magnetic moment vector "flipped" in (a) by an applied magnetic field, H , and in (b) by a phonon with a frequency equal to the Larmor frequency, due to vibrations of near nuclei in the surrounding lattice structure

ture of organic radicals in solution is expected to be influenced strongly by solvent, cation species and concentration, and temperature. The most simple approach, that of rationalizing observed spectral variations on the basis of electrostatic perturbations due to cations appears to give reasonable explanations of the effect of environmental factors on hyperfine structure, resonance line widths, and g -values (8)—at least in so far as the anthracene and azulene anion radicals are concerned. Such "calibration" work as this is absolutely essential to the development of ESR techniques for determining environmental effects on organic radicals.

There are signs that heats of hydration may be deducible from the effects of electrostatic perturbation of spectral structure. In ESR studies of metal ortho-quinone complexes, Eaton (9) found a correlation between proton hyperfine structure and the metal heats of hydration. While precise quantitative agreement with theoretical calculations is still lacking, the qualitative aspects of the relation between complexing and ESR spectral features seem predictable from a model which uses the Coulomb integral (electrostatic interaction) of the semiquinone oxygen as the major cause of resonance line splitting. Entirely similar researches on alkali metal-*o*-dimesitylbenzene (10) reveal that spin density at the metal ion varies with the inverse square root of the metal ion's radius. This has clear implications for the nature of the covalent bond linking the alkali metals to the semiquinone oxygen; as the radius of the metal ion diminishes there should be a parallel increase in the covalent nature of the metal-oxygen bond, i.e., in order of increasing covalent character: cesium, potassium, sodium and lithium.

The hydrogen bonding of water to the nitro group of nitrobenzene anion radical has been described as being the main reason for the correlation between solvent shifts in the optical spectra of the radical and the nitrogen hyperfine struc-

ture (11). Also explained in terms of hydrogen bond formation are variations of proton hyperfine structure in fluorenone anions as a function of the composition of dimethylformamide-alcohol solvent mixtures.

CRYSTAL STRUCTURE ANALYSIS

Detailed information on the symmetry of crystal structures surrounding a paramagnetic atom (an atom possessing unpaired electrons) can be obtained whenever the g -factor or spectral line splitting varies sufficiently with the angle of incidence of the applied magnetic field.

If the magnetic field is rotated round in the crystallographic plane, and observations of the resonance frequency are made every few degrees, then the direction of the crystallographic axes can be determined from the points where the spectra from the different ions in a unit cell coincide. From the observed frequencies the g -factor variation for each molecule in the unit cell all around the plane can be computed and the crystallographic axes located from the coincidence points (Fig. 3). By just such a procedure the haem planes (containing the paramagnetic center, iron) of various myoglobins were mapped (12).

APPLICATIONS IN BIOLOGY

Since Commoner, Townsend and Pake first noted the value of ESR signals in studying biological function some twenty years ago, a great deal of biological research work has been accomplished through the use of this relatively new spectroscopic tool. Most of this work has been directed at those aspects of function which involve the formation of free radicals. But in biological systems the appearance of these chemical species is so widespread that a great variety of biochemical systems is susceptible to study by ESR spectroscopy. Of particular interest currently is the use of this technique in connection with the elucidation of the mechanisms of enzyme catalysis and the effects of harmful radiation on cellular activity.

Enzyme studies. As one might expect, the enzymes most accessible to ESR probing are the oxidative enzymes, since in these molecules the essential activity underlying their catalytic properties seems to involve copious numbers of unpaired electrons constantly in transit in coupled oxidation-reduction systems. Therefore it is no surprise that the most successfully researched enzymes are the flavoproteins. But in addition to the flavin component of these catalysts there is a metal which is essential to their function, so that these enzymes also offer an unusual opportunity to investigate the role of paramagnetic centers in living systems. Cerruloplasmin and laccase, for example, contain copper; cytochrome oxidase possesses iron; and xanthine oxidase has iron and molybdenum. Investigations of the flavin and metal moieties of the metalloflavoproteins have been carried out separately. The spin density distribution in flavin anion radical has been mapped

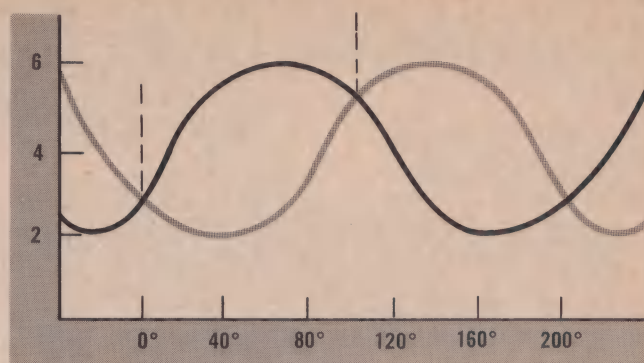
by proton and nitrogen hyperfine splitting (13).

Ceruloplasmin is an oxidative enzyme containing eight copper atoms per molecule. ESR studies of this substance have confirmed previous chemical analyses which have assigned three to four copper atoms to the cupric state and the remainder to the cuprous state. The role and possible intramolecular interactions of metal ions in ceruloplasmin is of especial interest now, particularly in the case of dog ceruloplasmin which is being studied now, with the aid of ESR spectroscopy, by Peissach at the Einstein Medical College.

Xanthine oxidase probably has undergone more extensive ESR probing than any other enzyme. Of great importance for the continued study of the function of this enzyme in biochemical reactions was the introduction of a rapid freeze technique (14) with time resolution in the millisecond range, which permits investigation of the kinetics of the various paramagnetic components of the enzyme as they interact with substrate. At this point it is conjectured that the electron transfer path in xanthine oxidase involves Mo (VI), Mo (V), Fe(III), and Fe(II) (15).

Carcinogens and drugs. Very little is understood of the mechanisms underlying the action of chemicals known to induce cancer in animals or drugs which affect metabolism. One piece of useful information consists of the fact that many of these molecules have rather small electronic ionization potentials and consequently they may be imagined to form free radicals under physiological conditions. A number of cancer inducing dyes, e.g., acridine orange and proflavine, are positively charged at physiological pH, and they bind strongly to the negatively charged nucleic acids, working out their mutagenic and cancer-inducing potential in this fashion. ESR techniques provide a convenient general means for studying the molecular mechanisms of the action of various positively charged species of drugs and carcinogens; one study in particular, while not of extraordinary basic interest, could point the way for the use of ESR signals for the early detection of the cancer state: Vithayathil (16) has shown that chemically different carcinogens, e.g., p-dimethylamino azobenzene and thioacetamide, cause a transient signal distinctive of a free radical species soon after they are introduced to the diet of rats. This signal seems to be the earliest specific response to carcinogenic stimulus.

Radiation damage studies. The extensive interest in the use of ESR to investigate the biological effects of ionizing radiation is reflected in the 1965 meeting focusing on this subject sponsored by the National Academy of Sciences (17). The indications from this meeting are that radiobiologists are in rather an embarrassing position: classical organic chemists would be shocked at attempts to study the mechanism of a reaction for which the products have not been determined—yet this approach has been forced on investigators seeking the effects of radiation on such a complex



3

g-value variation in myoglobin. Cross-over points of g locate crystal axes in this 2 molecule/unit cell crystal

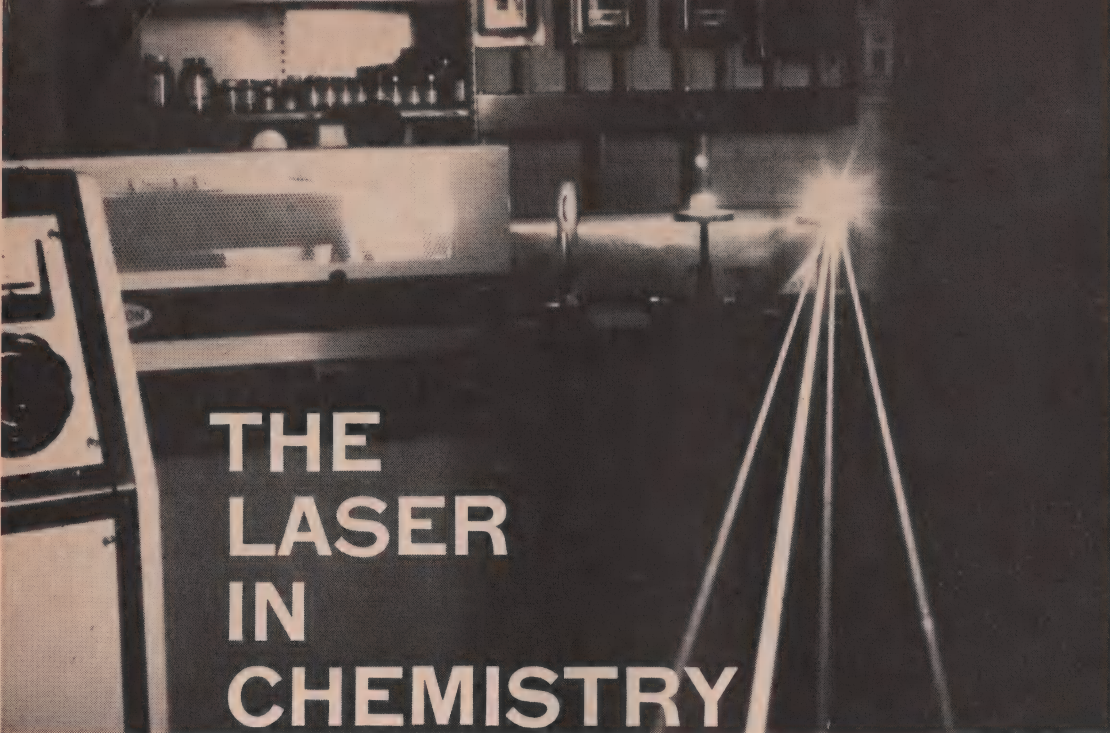
system as the living cell. However, on the positive side there is no question that ESR probing has been of extraordinary value in the effort to hunt down the first chemical lesions—in the form of free radicals—induced by ionizing radiation. The essential questions still unanswered concern the chemical changes that lead to genetic damage, i.e., to the cell's DNA—although one may also ask about primary damage to enzymes, ribosomes and RNA.

Although a specific lesion of bacterial DNA due to ionizing radiation has been suspected for some years, little insight has been obtained beyond the fact that, whatever this lesion is, it is something serious which leads to degradative processes. Most researchers in this area are applying ESR spectroscopy to the task of finding how thymine and perhaps uracil dimers are produced on DNA, since these dimers are now prime suspects as the initiators of mutagenic changes. More specific information on radiation effects has been extracted from the irradiation of enzymes (18). Here it has been shown, for example, that irradiation of the enzyme ribonuclease produces a free radical which leads to the formation of a second free radical that combines with cellular oxygen to inactivate the enzyme as a catalyst.

It has been found in these instances however that SH compounds protect the cell against subsequent damage following the formation of the first free radical. ESR spectroscopy has helped here to establish the case that SH compounds prevent the formation of the second free radical which can be inactivated by oxygen.

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THE LASER IN CHEMISTRY

After a slow start, the commercial laser is on its way to becoming a general-purpose tool in chemical research. Applications range from excitation of specific vibrational levels to vaporization of small samples for spectroscopic analysis

by LEO PARTS, *Monsanto Research Corp., Dayton, Ohio*

As little as a year ago the laser's position in the world of chemistry resembled that of a solution for which there was no problem (1). But today we can report that this novel tool has begun to "find" problems and to "provide" solutions in the area of chemistry at an accelerating rate.

Coherent radiation sources are now available for the microwave, infrared, visible, and ultraviolet spectral regions. In particular, the progress in the development of infrared lasers has been remarkable during the past year. One can now anticipate their application in work involving specific vibrational excitation and as very intense heat sources. Current developments on laser systems are expected to produce visible and infrared c-w lasers of considerably higher power output (2). The continuing improvement in performance characteristics of UV-lasers is of at least equal significance from the photochemical viewpoint. These developments will greatly broaden the scope of reactions accessible for laser-chemical studies.

The application of lasers as light sources, or more generally as energy sources, for applications other than photochemistry merit attention. Some unique uses have developed. As the laser technology advances and as chemists learn to use these versatile tools, significant new applications will surely emerge.

LASER CHARACTERISTICS

It has been half a century since Einstein predicted, in 1917 (3), that atoms can exhibit population inversion of energy states in an electromagnetic field and suggested that induced emission of radiation would provide a mechanism for

establishing the thermodynamic equilibrium in such systems (Fig. 1). Although it was not until 1960 that emission of stimulated radiation from a ruby crystal at 6943 Å was first reported by Maiman (4, 5), today the unique characteristics of laser radiation are common knowledge. Those that are of great interest to chemical applications include: very high intensity, spatial and temporal coherence, and very low beam divergence. The coherence characteristics imply that the radiation is monochromatic.

On the other hand, the utility of lasers for specific chemical purposes largely depends on some additional output characteristics — emission

wavelength, average power, peak power, and the manner of operation (c-w or pulsed).

Presently available laser systems provide either continuous emission or pulses of radiation of millisecond duration. The pulse length can be shortened into the nanosecond range at a sacrifice of energy and at a gain in peak power by using switching devices.

The wavelength range for coherent radiation emission of gas lasers extends from about 2358 Å to 120.08 μ (6, 7). The output power extends from fractions of a milliwatt to more than 700 watts c-w (8). The table shows the wavelengths most readily obtained on a continuous emission basis in commercial instruments. The present power output limits of the commercial c-w gas lasers are: He-Ne, approx. 125 mw; Ar, 10w; Kr, 5w; Xe, 1w; CO₂, > 1000 w. Available UV-emitting gas lasers provide repetitive pulsating radiation at a very low average power level.

Commercially available ruby and the neodymium solid-state lasers provide pulses ranging in energy from fractions of a joule to 12 kj. The available peak power in Q-switched operation, emitted as a pulse of 1 nanosecond (10^{-9} sec) duration, is 10 gigawatts (10^{10} w).

The semiconductor injection lasers emit mainly in the infrared spectral range. They are usually characterized by high beam divergence and low average power output.

CHEMICAL APPLICATIONS

If the interest of chemists in laser chemistry is correctly reflected by the number of publications that have appeared, it has developed slowly

(10). But if we look closely at these reported studies as well as unpublished studies, we can point to some very interesting and significant accomplishments that should kindle further interest in this area of chemistry.

Multiphoton-induced processes. Some basic requirements have to be met to effect chemical changes by electronic excitation with radiation of frequency ν . First, the chemical species must possess an excited energy state defined by the relationship:

$$E - E_0 = nh\nu.$$

E and E_0 are the excited and the ground energy level of the molecule and n designates the number of photons utilized for excitation. Secondly, for absorption to occur, the transition moment integral must have a nonzero value. Thirdly, the electronically excited state must be chemically more reactive than the ground state.

Most known photochemical processes occur through excitation by a single photon $h\nu$. The possibility of simultaneous two-photon absorption was suggested by Göpert-Mayer (11). This effect depends on nonlinear electronic polarization properties of materials, which become observable under intense irradiation.

Studies of luminescence, caused by two-photon absorption in $\text{CaF}_2:\text{Eu}^{+2}$ (12), anthracene (13-18), and the naphthalene-tetrachlorophthalic anhydride charge transfer complex (19) have been reported. About 10^6 quanta are absorbed for each fluorescence photon emitted with frequency higher than ν_L (the laser emission frequency).

Two groups describe chemical reactions in condensed systems effected by multiphoton processes—one involving polymerization experiments with styrene and its derivatives, and another the two-photon induced decomposition of silver chloride.

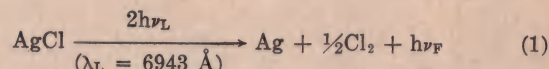
Pao and Rentzepis (20) achieved polymerization of styrene, *p*-isopropylstyrene and chlorine-sub-

Wavelengths of commercial lasers (9)

Gas lasers				Solid-state lasers	
λ (Å)	Gas	λ (Å)	Gas	λ (Å)	Solid
4880	Ar	6271	Kr	3472	Ruby
5145	Ar	6328	He-Ne	6943	Ruby
5208	Kr	6871	Kr	10600	Neodymium
5419	Xe	33910	Co ₂		
5940	He-Ne	106000	Co ₂		

stituted styrene derivatives by exposing monomers to pulsed radiation from a ruby laser. Photo-initiation of styrene polymerization by conventional methods cannot be effected at wavelengths longer than 4000 Å in the absence of sensitizers. Since no sensitizers were used in the study with the ruby laser ($\lambda = 6943$ Å), the observed polymerization is ascribed to a multiphoton initiation process, with the two-photon process presumed to be the principal one.

Rousseau, Leroi and Link (21) observed photolytic darkening at the surface of silver chloride exposed to radiation from a pulsed ruby laser of 30 kW peak power. The formation of colloidal silver



was accompanied by fluorescence at frequencies ν_F ($\lambda_F = 4000\text{-}5500$ Å). The emission of the blue-green radiation was found to be proportional to the square of the incident intensity of the laser light, suggesting that the process was caused by two-photon absorption. The fluorescence efficiency of the process was $\sim 10^{-6}$.

The unharmonicity of electronic polarization characteristics of materials is very small and multiphoton-induced reactions had not been observed prior to the availability of coherent radiation sources. The absorption of very intense coherent radiation at wavelengths at which no absorption can be detected at low intensities, has now been shown to produce electronic excitation. The requirement for two-photon absorption is the availability of energy levels in materials which correspond to the total energy of the two quanta; i.e., that materials absorb radiation of half the wavelength of laser radiation. Even with the intense pulsed laser radiation sources, the frequency of occurrence of these novel multiphoton-induced reactions, observed thus far, is very low.

Ionization and dissociation of gases. Considerable interest involving both experimental (22-27, 65) and theoretical (25, 26, 29-37) work has developed in the effects of intense laser radiation on gases. Ionization occurs in the focus of intense pulsed laser beams. Multiphoton processes, inverse bremsstrahlung absorption, and the electrostatic field associated with the electromagnetic beam have been suggested as the factors causing

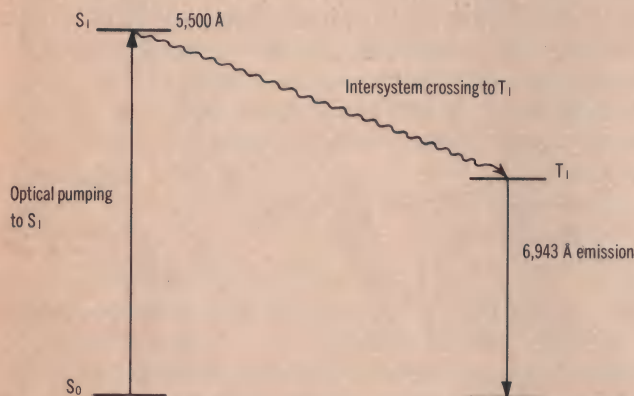


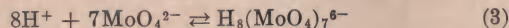
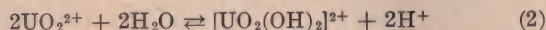
FIG. 1. Laser action in ruby crystal is observed by first exciting electrons in ground state S_0 to state S_1 which subsequently decay to metastable state T_1 . When population of electrons in T_1 exceeds that in S_0 , spontaneous decay from T_1 triggers other T_1 states throughout crystal to decay, resulting in intense burst of coherent radiation

dielectric breakdown (27). The processes are complex and further studies are needed to elucidate the mechanisms. An interesting finding is that the breakdown power does not depend critically on the laser emission wavelength (27).

The decomposition of methane, when subjected to pulsating radiation from a ruby laser, yields acetylene as the major product (28). Thus, the product distribution resembles that which one would anticipate from high-temperature thermal degradation, rather than the distribution expected from ionizing radiation. A very high percentage of light (50-83%) was found to be absorbed in the ionization of polyatomic molecules by the intense Q-switched ruby-laser beam (28). The results suggest (28) that the giant pulse laser can be used to study very high-temperature gas reactions.

Heating and degradation in condensed phases. Laser-heating offers advantages in kinetic studies of very fast reactions (38, 39). In such studies a sudden temperature jump is imposed on a system, following which relaxation measurements are made. The commonly used Joule heating method requires at least 5 microseconds to raise the system temperature. With Q-switched laser pulses, temperature rise times of the order of 10 nanoseconds are feasible.

Using copper nitrate as the absorbent in aqueous systems, Eyring and coworkers (38, 39) have studied equilibration rates in ionic systems:



The reaction of aluminum with water has been observed under conditions that may exist during nuclear reactor excursions. These were simulated by heating small aluminum particles, immersed in water, with a focused laser beam (40).

The effect of pulsed ruby laser radiation on polycrystalline graphite has been investigated (41, 42). Fragments ranging from C_1 to C_{14} were detected by a mass spectrometer (42) in the jet of the gas ejected from the surface. Analysis showed that the blue-white light emitted by this jet is composed of the emission lines of CN and C_2 (41). The rotational and vibrational "temperatures" were found to be in the range 3.9×10^3 °K to 2.2×10^4 °K.

Solid methylene blue subjected to pulses of radiation from ruby lasers (43, 44), has been observed to yield methane, ethane, and propane, suggesting that fragmentation of dimethylamino groups occurs with a concomitant formation of other highly reactive groups. Control experiments using conventional thermal degradation yielded different distributions of products. Propane was absent among the products in the latter experiments. These results reflect the influence of the rate of energy transfer upon the distribution of products from degradation reactions.

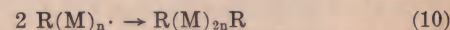
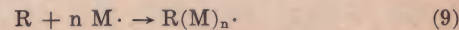
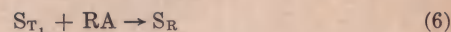
Single-photo laser-induced polymerization. Shortly after the discovery of the lasers, photo-

sensitized acrylamide-calcium acrylate systems were used to measure the light intensity distribution in the beam emitted by ruby lasers (45). The sensitizing system was composed of methylene blue and N,N,N', N'-tetramethylethylenediamine. The height of the three-dimensional colloidal gel buttons was directly related to the beam intensity.

More recently ultraviolet radiation (3472 Å), obtained by frequency doubling of ruby emission, has been used for azobisisobutyronitrile-catalyzed polymerization of vinyl acetate (46).

In general, single-photon-induced photosensitized polymerization processes make highly efficient use of visible laser radiation in terms of the extent of the physical and chemical changes that can be effected. The photosensitized polymerization can be conducted at room temperature. The amount of sensitizer required is very small. The high radiation flux available from laser systems makes possible very high polymerization rates. One can take advantage of the low divergence of laser beams to initiate polymerization reactions remotely.

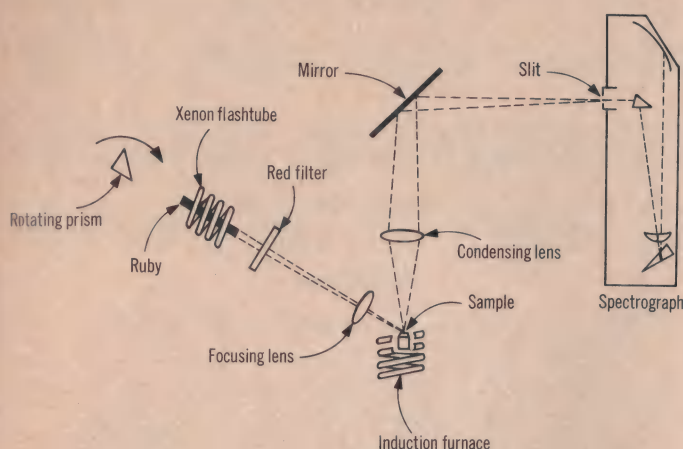
The following mechanism has been suggested (47, 48) for visible light-induced polymerization reactions:



S_{S_0} = the ground electronic state of sensitizer; S_{S_1} = the first singlet excited state; S_{T_1} = in first triplet excited state; RA = reducing agent; S_{R} = reduced form of sensitizer; O_2 = oxygen; S = catalytically active form of sensitizer; M = the olefinic monomer; $\text{R} \cdot$ = polymerization initiating radical; $\text{R}(\text{M})_n \cdot$ = growing polymer chain; $\text{R}(\text{M})_{2n} \text{R}$ = the polymer molecule.

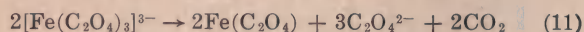
In our own investigations of argon-laser-induced polymerization of acrylamide (49), the monomer is transparent in the spectral range of strongest argon emission line (4880 Å). To make most efficient use of the coherent radiation, we use sensitizers that have strong absorption bands in this region.

The photochemical efficiency of a sensitizer depends on the rates of electronic and vibrational relaxation relative to the rate at which the polymerization is initiated by the sensitizer in the lowest triplet state. 4', 5'-Dibromofluorescein (4960 Å) eosin (5150 Å), and Acridine Orange (4890 Å) are examples of sensitizers that catalyze polymerization initiation by the 4880 Å argon laser emission. (Wavelengths in parentheses are those of the absorption maxima). The sodium riboflavin-5-phosphate sensitizing system had previously been used to study incoherent radiation-induced polymerization of acrylamide (48). Utiliz-



ing 4880 Å radiation from the argon laser, we have obtained best results with the 4', 5'-dibromofluorescein-N, N, N', N'-tetramethylethylenediamine sensitizing system. More than a thousand monomer molecules have been polymerized per quantum of absorbed laser radiation.

Actinometer for argon lasers. Photochemical decomposition of potassium ferrioxalate has become the accepted standard reaction for incoherent light intensity measured in a broad range of the visible spectrum (50, 51).



The extent of the photochemical reaction can be determined spectrophotometrically with high accuracy.

It would be very convenient for chemists to use the same system for precise measurements of c-w coherent radiant energy. Furthermore, there is an interest in a quantitative comparison of the quantum efficiency of coherent and incoherent radiation-induced reactions in a randomly ordered system under conditions of low radiation intensity.

Our experiments on the above reaction were conducted with the 4880 Å emission from the argon laser (52). The radiation intensity was 1.3 w/cm² and an Eppley laser thermopile, Model LT-100, was used for energy measurements.

We first measured the molar extinction coefficient of potassium ferrioxalate with 4880 Å argon laser radiation. Subsequently, ferrioxalate solutions were exposed to coherent radiation for periods varying from 10 to 250 sec and the quantum yield (Φ) at 25°C was determined as 0.97 ± 0.05 .

By comparison for incoherent radiation at 4880 Å, Hatchard and Parker (52) obtained $\Phi = 0.92 \pm 0.02$.

The potassium ferrioxalate actinometric system can thus be used to obtain reliable energy measurements of 4880-Å c-w radiation emission from argon lasers. The quantum yields for the coherent and incoherent radiation-induced reactions in the ferrioxalate system are identical within the accuracy of the measurements. The experimental

results indicate, as anticipated, that the photochemical effects of a low intensity beam of coherent radiation on a randomly ordered system do not differ from those observed with incoherent radiation.

PHYSIOCHEMISTRY AND ANALYSIS

Very interesting and useful applications of lasers have been reported in the area of physical and analytical chemistry. They have, for instance, been used extensively for Raman spectroscopic studies. Porto has used laser sources to obtain Raman spectra of gases, liquids and solids (53) and Weber (54) has developed techniques for exciting the Raman spectra of low-pressure gases and vapors with helium-neon and argon ion lasers.

In investigations of energy transfer among vibrational states in polyatomic molecules the monochromaticity of laser sources makes it possible to excite a specific vibrational level and observe its decay. Thus Moore and Yardley (55) excited the asymmetric stretching mode of methane (3018 cm⁻¹) with pulses of the 3.39 μ radiation from a He-Ne laser. By observing vibrational fluorescence from the lower-lying bending vibration (1306 cm⁻¹) they determined the relaxation time for transfer of vibrational energy from stretching to bending.

A 1-mw c-w helium-neon laser has been used in conjunction with an ultramicroscope to study light scattering in crystals (56). The low-power laser was found to be significantly superior as a light source compared with the conventional mercury lamp, mainly because of the low divergence of the beam and the monochromaticity of the light. Latex particles, only 880 Å in diameter, that were suspended in water were visible by the eye. Considerable improvement in detection will result from the use of more intense laser sources (56).

Laser-interferometric measurements have been used in the study of transport mechanisms around the dropping mercury electrode (57). Laser interferometry has also aided the investigation of electronic recombination in rare-gas after-glow plasmas (58, 59). Spatial and temporal behavior of medium density (10¹³-10¹⁴ electrons/cc) plasmas was studied.

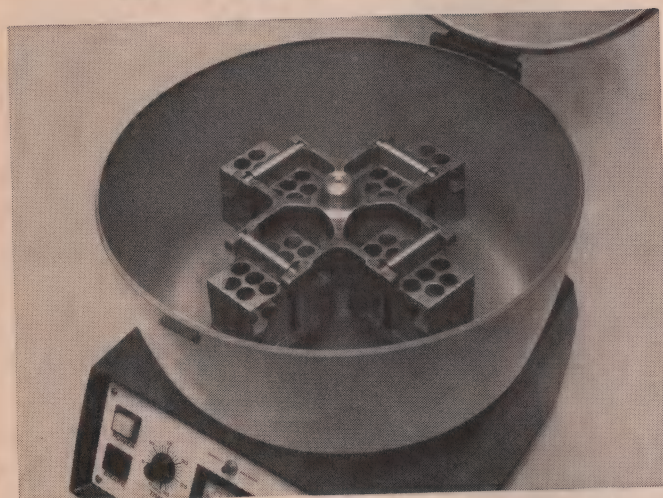
Laser microprobes have been used in conjunction with mass and emission spectrometers for the analysis of solids. When specimens are subjected to pulses of intense radiation, the evolving vapor jets are either sampled for mass spectrometric analysis (60, 61), or their emission spectra are recorded photographically (62, 63). With these methods one can analyze metal and refractory materials. The emission spectrometric method has been used to analyze samples only a few microns in diameter (62), and also to analyze molten metals by remote means (63) (Fig. 2).

Laser microprobe sampling for emission spectroscopy has found unique application in histochemistry (64). A detection limit of 10⁻¹⁴ moles of calcium or magnesium in 1-μg samples of dried

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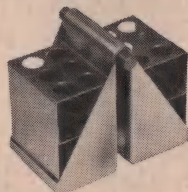
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tissue has been achieved. The laser beam can be focused very sharply for intracellular sampling and for in situ elemental analysis. One can also use small pulses for in vivo analysis of exposed tissues (64).

* * *

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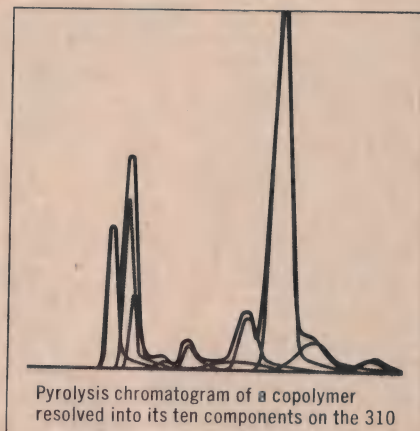
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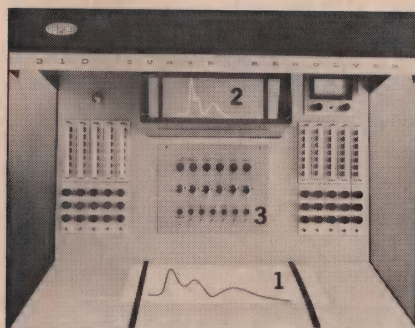
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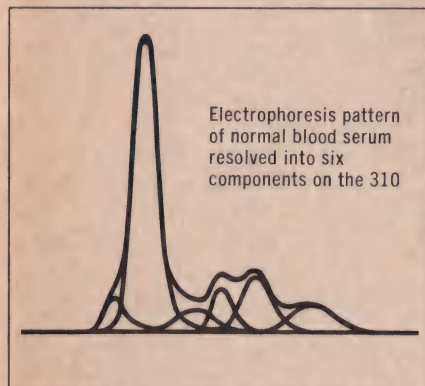
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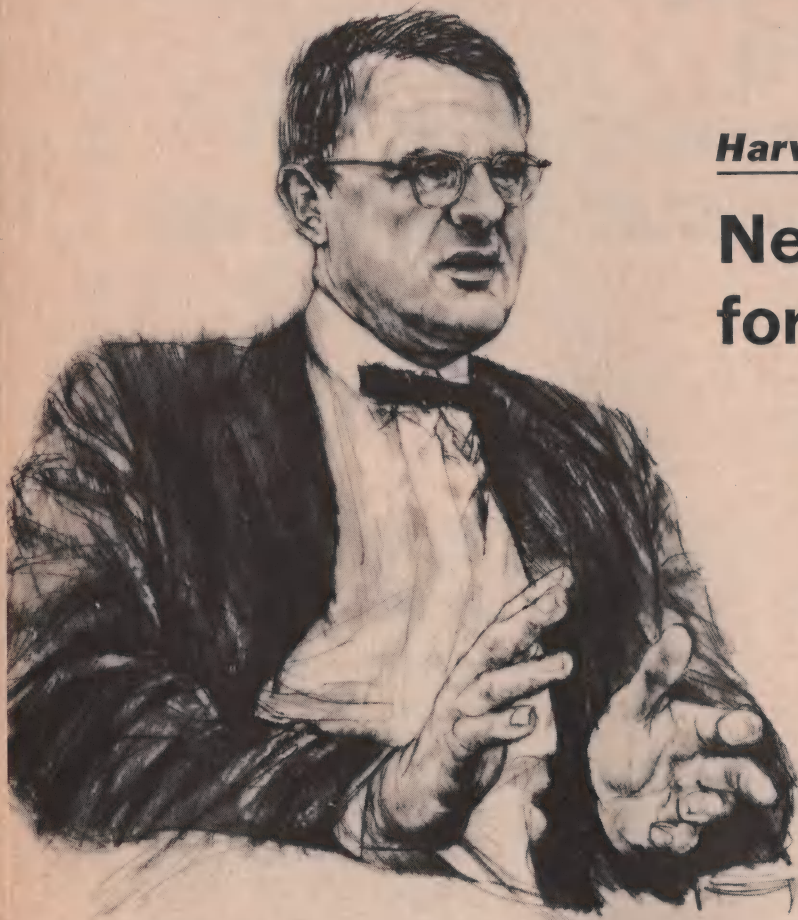
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That research-and-development has become one of the important tools our nation depends on to achieve its goals is now widely recognized. It is a common assumption that a substantial fraction of our Federal budget will continue to be invested in R & D activities in the future. I would go even further and predict that the percentage of the budget that goes to R & D will eventually become considerably higher than it is now.

The kinds of things the government does have become more complex than they used to be and will become even more complex in the future. With more complex activities you need more information about what you are doing and it is the function of research to get information.

I see the apparent leveling off of the research budget this year as only a temporary phenomenon—the result of the natural development of certain missions. Although there will always be short-range fluctuations, with the increasing complexity of society it seems almost inevitable that the long-term trend of R & D will be constantly upwards. There is no easy way to foresee what the ceiling might be in terms of the percentage of the total budget. For instance, it is perfectly conceivable to

me that some years hence we could be spending as much as 50% of our federal budget on R & D activities.

Thus, the question of how we can optimize the deployment of our scientific resources, already an important question, is likely to increase in importance as time goes on. In my view it is essential to this purpose that we find ways to provide channels for horizontal communication within the vertical hierarchy of agencies and departments that constitute our government.

Perhaps the best place to start is with our national laboratories. One of the direct by-products of our departmental system of managing R & D is the creation of large Federal research institutions devoted to the missions of particular agencies and subdivisions within agencies. As the organization of the agency becomes obsolete, so does the mission of the laboratory—a process that is often accelerated by success. The range of technological capabilities represented by these laboratories is extraordinary, but after a few years the magnificent machinery tends to get devoted to less and less significant problems, and it is extremely difficult to redefine their missions in response to the changing goals of Federal science.

These laboratories—in-house and captive—represent nearly \$4 billion of annual national investment, nearly 3 times our support of universities proper, yet we seemingly find it very difficult to redeploy our national scientific apparatus to

HARVEY BROOKS is dean of Harvard's School of Engineering and Applied Physics and chairman, Committee on Science and Public Policy, National Academy of Sciences.

deal with new technical problems and missions without creating wholly new institutions or agencies or sometimes turning to the private sector where it is inappropriate. We do not treat our Federal labs as a common national resource to be used flexibly for many of the purposes of government. Rather we tend to regard each lab as the inviolable possession of its agency.

I feel it is time we learned how to use these institutions more flexibly for national purposes with less worry about roles and missions. I admit there is a risk here—an increased risk—of that shibboleth of management, “duplication and overlap.” Furthermore, such institutions do not necessarily include the proper mix of skills to shift from, say, nuclear power to biomedical technology, but I believe that with better long-range planning we could redploy some of these institutions over a

“Some years hence it is not inconceivable that we could be spending as much as 50% of our Federal budget on R&D activities.”

period of years, and without merely adding appendages (and budget) to the existing laboratories. In fact, there is evidence that the laboratory managements themselves are approaching this ever more imaginatively than the supervising Federal apparatus. A good example of this, of course, is Oak Ridge's entry into the water desalination field.

The suggestion has been made that the larger, broad-spectrum laboratories might be operated as a group by a separate government corporation set up along the lines of the Tennessee Valley Authority. Then federal agencies interested in placing research contracts would go to this central structure.

I personally would not go this far but would have each laboratory continue to be mainly responsible to the agency which it was set up to serve while allowing for the possibility of it serving other agencies as well. Over a period of time if its other functions grow beyond the original one, at some point the new activity could be split off somehow into a separate organization. In this way you would avoid what happened to the Bureau of Standards Laboratory in the early 1950's when it was found that the Laboratory was doing as much as 70% of its work for the Defense Department rather than for the Commerce Department.

Organized in this way the national labs would have the flexibility and mobility of people needed to make them ideal centers for mission-oriented research. I don't worry about their competing with universities for this work because I don't believe universities should be doing highly specific mission-oriented or programmed research. A university soon finds that problem-solving research

is incompatible with its educational function.

Unfortunately we have a tendency these days to think that universities are all-purpose institutions—if you can't find anybody to do something you ask a university to do it. There are lots of things that universities can do and many strongly mission-oriented projects may best be done in close association with a university. But I don't think the university should take *primary* responsibility for the solution of practical problems.

There is no objection, on the other hand, if the university sets up a separate institution to do mission-oriented work. For instance, MIT operates Lincoln Lab. In fact, there is a virtue in having such mission-oriented labs associated with or geographically close to the university so that they can interchange people and students can come in contact with people doing mission-oriented work. Lincoln Lab has been very beneficial in many ways both to MIT and to Harvard. It is valuable to have this kind of geographical proximity but equally important to have administrative separation. In particular, it is very bad when a university becomes financially dependent on a mission-oriented institution.

If we were to move in the direction of more freedom for national laboratories, the management of Federal science might become considerably more complex, and the problem of dilution of agency responsibility more worrisome. On the other hand, such a change of philosophy would lead to quicker identification of new missions and goals of the working level, and would have the virtue of bringing to our thinking fresh minds, uncontaminated with the knowledge of what can't be done. I think we could afford to pay the price of some initial naiveté and fumbling for the sake of the fresh look, the breaking of obsolete communications patterns, and the formation of new feedback loops which might result.

I think also in this same connection government may have certain lessons to learn from private enterprise. If we circumscribed their missions less, I think we could encourage a greater entrepreneurial spirit in some of our labs, and permit

“I don't believe universities should be doing highly specific mission-oriented research.”

some labs to grow and others to decline as they were able or not to sell their skills and their ideas to other Federal agencies. At least it might be worth experimenting with a kind of limited market economy within the Federal structure and a modest amount of competition with some of its rewards and penalties. Such a scheme would foster the horizontal transfer of technologies to new missions which I believe to be increasingly necessary to innovation and progress within the Federal structure.

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FEBRUARY, 1967 • SCIENTIFIC RESEARCH

After 32 years, new treasure from Fermi

MOLECULES, CRYSTALS AND QUANTUM STATISTICS by Enrico Fermi, translated by M. Ferro-Luzzi and edited by Lloyd Motz (W. A. Benjamin Inc., New York, 1966, \$12.50, 300 pages)

Reviewed by Alan Holden

I wish that Enrico Fermi's little book had been at hand when I undertook to re-enter scientific work in 1935 after ten years in other pursuits.

At the beginning of that decade modern quantum mechanics had taken its start in the papers of Erwin Schroedinger and Werner Heisenberg. By the decade's end the structure had been largely perfected by such intellectual giants as Arnold Sommerfeld, Niels Bohr, Max Born and Wolfgang Pauli. My task of catching up with that enormous construction was unassisted by any such summary as Fermi's, and I had to tackle it by sledge-hammering the material from pedagogically inferior sources.

To be sure the book was at hand, but in another corner of the Tower of Babel. It appeared in Italy in 1934, as part of a projected comprehensive treatise on physics under multiple authorship, initiated by the Italian National Research Council to assist the younger generation of Italian students in mastering modern physics. The uncompleted project represents perhaps the last good fortune of that generation.

The book would still form a good introduction to its subject matter for the graduate student of today.



"The Cardinal, the Pope and the Basilisk"—early nicknames for physicists Franco Rasetti (l), Fermi and Emilio Segrè (r) above. Segrè, Persico, Fermi in holiday mood, right



The student would need some prior introduction to quantum mechanics, no doubt provided to Fermi's Italian student by Persico's companion volume in the original treatise, and accessible now in many introductory textbooks. He will then find Fermi's discussions breezy and enthusiastic, with the pleasant interaction of theory and its comparison with experiment that always marks the writing of an active scientist who is busy balancing theory and experiment in his own work.

In at least two respects the book (now published for the first time in English) will call upon the student's maturity if he has it, or cultivate it if he hasn't. In the first place the book offers him no problems on which he can test his mettle. In the second, he simply must be hospitable to a use of mathematics that keeps it always subservient to physical ideas. The sophisticates will float; the incorrigible literalists will sink.

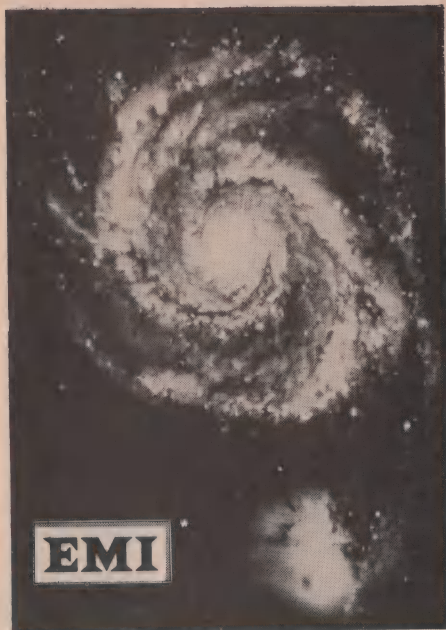
GUESSING GAME

To any reader already informed on its subjects, the book offers an interesting game of guessing what Fermi might have done to it were he revising it today—a game more

likely to be won by others than this reviewer who never met him. The enormous proliferation of experimental and theoretical work on molecules and crystals would challenge anyone's sense of style and taste in making suitable choices for the student. Fermi would probably refuse, knowing that a good book is personal, however impersonal its ostensible subject, and that his own activity had turned elsewhere.

To keep the book within its present compass, perhaps Fermi would abbreviate his treatment of the Raman effect; it was of active interest to him in the Thirties, but it takes a smaller place in the perspective of the Sixties. To support a discussion of the properties of molecules, Fermi would now find the results of more powerful tools. Any who would scrape together the benefits of making wars would put the development of radar on his list; radar provided the gear for studying the spectra of molecules in the microwave region.

Earliest came the study of the transitions between the rotational energy levels of the molecules in dilute gases, providing accurate values of their moments of inertia and hence of their bond lengths and of the mass-ratios of their



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SCIENCE BOOKSHELF

(continued from page 55)

isotopic constituents. Then, with the aid of large electromagnets, came the investigation of the electron-spin resonances in free radicals and in molecule in triplet and excited states, giving insight into how the electrons responsible for those resonances stray within a molecule, and *a fortiori* how the other electrons also stray.

In these studies the spins of the nuclei and their concomitant magnetic moments are important probes, contributing a detailed structure to the microwave spectra, and nuclear magnetic resonance spectroscopy developed to measure that structure directly. In a parallel development, study of the bonding in molecules was pushed down to radio frequencies in "direct nuclear quadrupole spectroscopy" which examines the energy levels of the electric quadrupole moment of a nucleus in the anisotropic electric field of the bonding electrons. Thus the fine structure and hyperfine structure of optical spectroscopy have been opened out to form the entire spectral structure in the newer techniques.

Surely Fermi's sense of scientific synthesis would now urge him to dwell on the interactions between our knowledge of his two major topics, molecules and crystals, which seemed less closely related in the Thirties. Crystal structures and molecular structures illuminate each other: under their combined light the chemical nature of so complicated a molecule as penicillin can be elucidated by such a worker as Dorothy Hodgkin. And the ideas of "crystal field theory" apply as well to the orbitals of electrons in molecules as in crystals, elucidating especially successfully the interatomic bonds having ingredients of d-electronic character.

REAWAKENED INTEREST

Without doubt Fermi's early spectroscopic interests would be reawakened by the studies of the electronic states of substitutional impurity ions, such as chromium in aluminum oxide, on which the recently developed solid-state lasers are based.

Now that theories of crystalline imperfections are better developed than in the Thirties, Fermi's strong sense of reality might urge him to deal with the relation between the real and the ideal crystal. The role of vacancies and f-centers in electrical conduction through insulators has become clear and can be quanti-

tatively demonstrated. The line-defects known as dislocations, hypothesized by Taylor and Orowan in the Thirties to explain the plastic deformability of crystals, have since been demonstrated directly.

Fermi might find today that the section of his book dealing with crystals would be crippled by excluding "from this program the discussion of the properties of metals." In its present form these properties appear only as applications of statistical mechanics, outlined in the third section. To be sure, metals and alloys have been so extensively studied in the intervening years that the body of theory and experiment would probably demand a separate volume in the style and at the level of this. But those studies have given insights into the properties of non-metallic solids as well, particularly into their electronic behavior.

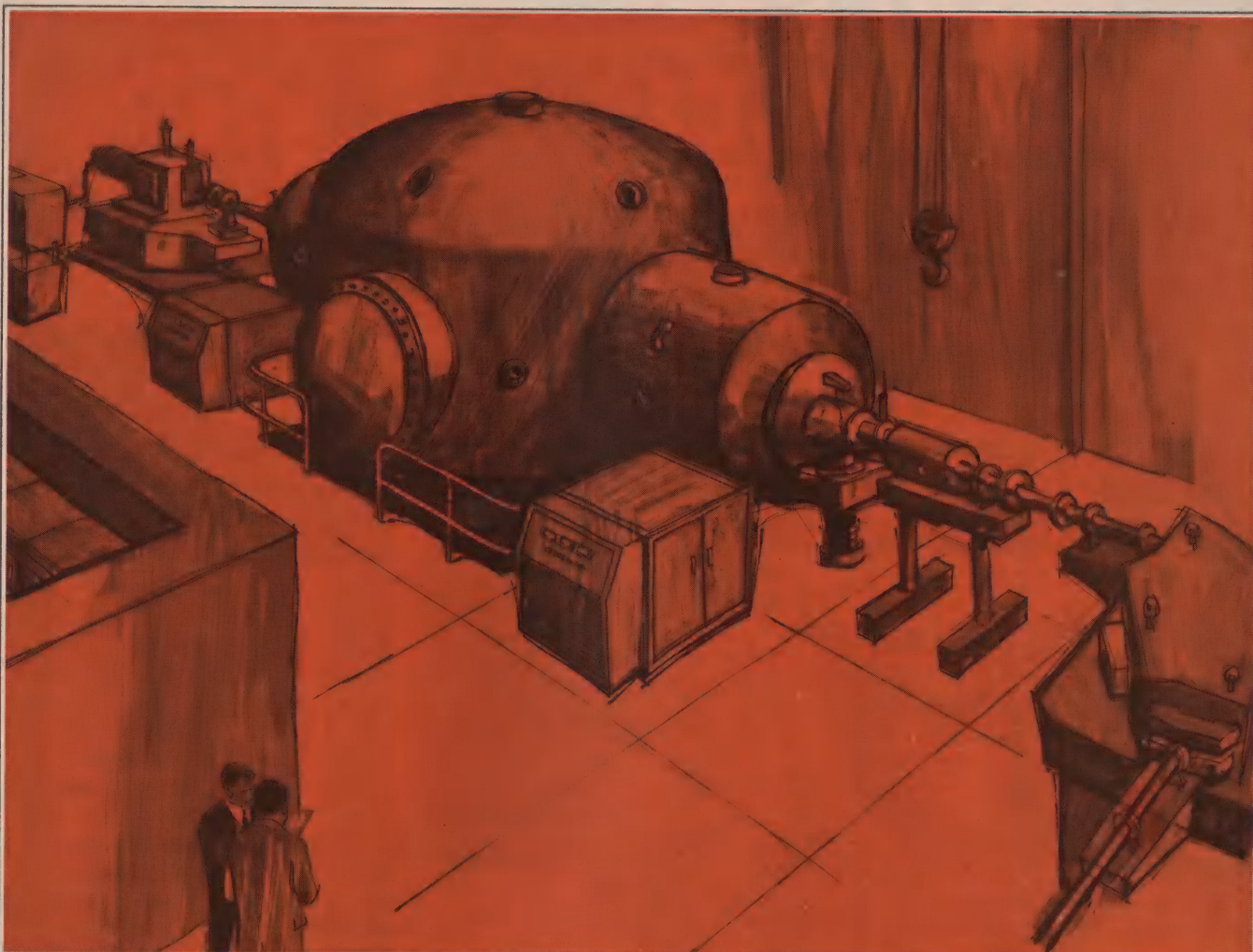
CONNECTING LINK

The major connecting link has been provided by semiconductors, particularly silicon and germanium, in which some electrons are thermally ejected from their localized bonds, to leave mobile "holes," and can wander through the crystal until they recombine with the holes. In the theoretical treatment of such solids the electronic energy-band theory, originated in the context of metals, becomes appropriate and illuminates insulators also.

Although the energy-band theory has been remarkably successful, it remains esthetically disturbing because it is based on the use of a one-electron approximation in a many-electron system. The years since Fermi wrote have seen a continuing effort to perfect "collective electron" methods of dealing with these problems, and the struggles toward a satisfying theory of superconductivity have sharpened this effort.

The very last topic in this book reminds us that the "Fermi-Thomas atom" embodied just such a treatment of the many-electron atom. The more general problem also demands such a mind as Fermi's, cutting through conventional methods with physical insight to reformulate the essentials of the matter in penetrating and simple terms.

Alan Holden is a member of the physical research department of Bell Telephone Laboratories, and the author of *The Nature of Solids* (Columbia Univ. Press, 1965).



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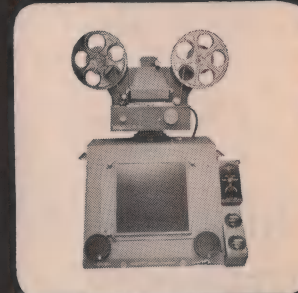
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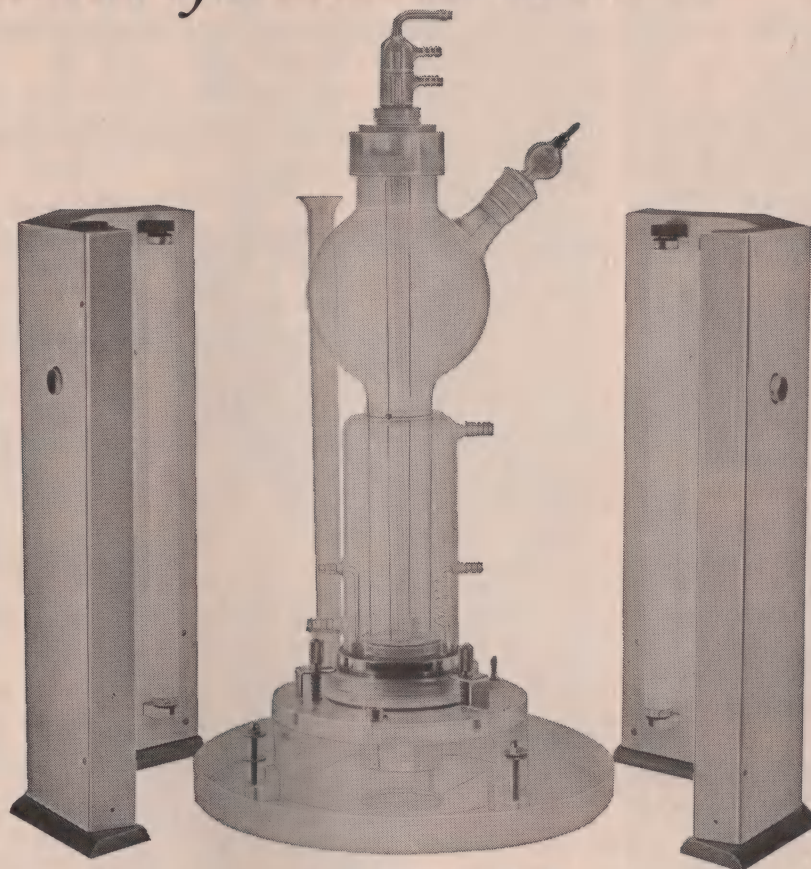
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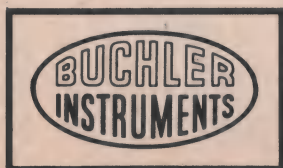
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*Designed by Drs. T. Jovin A. Chrambach, and M. A. Naughton at Johns Hopkins University, Baltimore, Maryland. Reference: Analytical Biochemistry, Vol. 9, No. 3, November, 1964
For further information, request Technical Bulletin #SR 3-1700

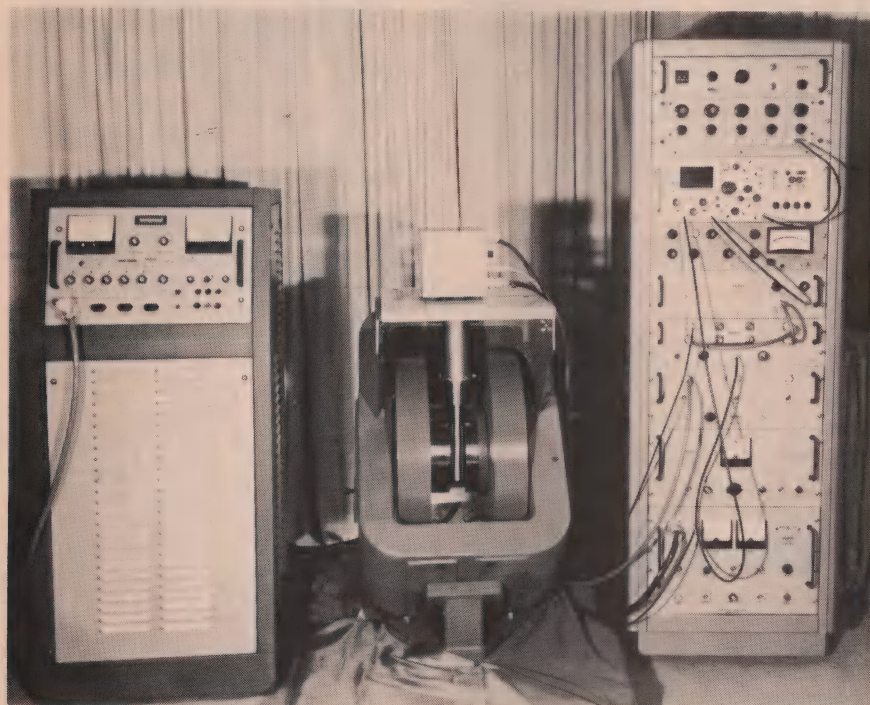


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NEW PRODUCTS

Many new instruments and techniques for physics research made their debut at the Physics Show held in New York late last month. SCIENTIFIC RESEARCH devotes its entire New Products section

this month to a review of some of the new equipment introduced. The Show was associated with the meetings of the American Physical Society and the American Association of Physics Teachers.



Spin echo: new approach to NMR spectrometry

Spin echo nuclear magnetic resonance spectrometry—a new technique with many applications in the study of the atomic and molecular dynamics of solids, liquids, and gases—was developed by Erwin L. Hahn, University of California, Berkeley, as a complementary technique to the conventional steady state NMR method.

The spin echo method, unveiled at the Physics Show, can now be used in research with the SE-30 system developed by Magnion Inc. in association with Hahn.

Steady state NMR systems employ a continuous wave of radio-frequency power to excite the nuclei of the material under study, whereas the spin echo system pulses the RF power at pulse-widths ranging from 0.5 microsec to 110 millisec. These pulses are applied in time repetition rates determined by the nature of the material. As the nuclei are excited

they also emit RF waves (following the pulses) which are measured as an expression of amplitude versus time. In particular the so-called spin echo results after the application of two pulses spaced by a given time interval. The spin echo occurs at a time after the second pulse which is equal to the time between the first two pulses.

The spin echo method advantage over the steady state technique is that more data concerning lifetimes of excited nuclear magnetic states are gathered together with information displayed by the free nuclear precession following single pulses. The nuclei are excited by each RF pulse into a coherent, uniform motion which then dies away. This is the "relaxation time" which is measured by the system. One relaxation time can be separated from another by the spin echo system more clearly

than with the steady state method, according to the makers.

Applications. The spin echo NMR system can be used to measure chemical reaction rates and the diffusion coefficients of molecules in liquids and gases. It can measure the coupling of a given nuclear magnetic moment to other nuclear magnetic moments and the nature of molecular motion in solids where the resonance line is extremely broad. This is particularly valuable in the study of polymers. The equipment can also pick out the interactions in molecules in liquid or gaseous state.

The SE-30 system can be used as an aid in classifying materials, because each material has a different relaxation time. Mechanical flow rates of liquids can be measured by flowing the sample through the apparatus. The sample is subjected to an RF pulse at a given position in a cavity, then flows to a second cavity where it is subjected to a second RF pulse. The time taken to change from excited to ground state can be related to the flow rate.

The apparatus. The SE-30 system incorporates a pulse programmer which operates with a coherent crystal-controlled RF source to produce pulses of magnetic field in an 0.5-in. single coil sample coil of about 60 gauss. The system includes phase-coherent receiving systems, oscilloscope display and a 9.5-in. magnet with precision power supply.—Magnion Inc.

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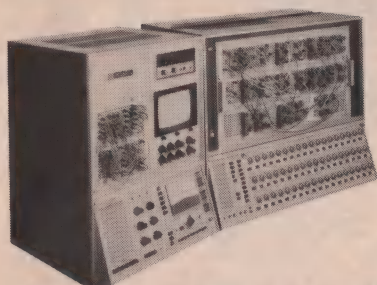
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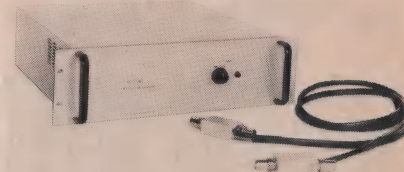
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field is applied across the discharge channel perpendicular to the output beam.—Avco Everett Research Laboratory.

Circle 152 on Reader Service Card



SWITCHING TIME CONVERTER

Designed for dynamic testing of solid-state logic-modules, Model 142 switching time converter features accurate, single-shot, time interval measurement of transients. Its range is 1 microsec-1 nanosec in a 50-ohm signal handling environment. All parameters of the instrument are fully programmable, with programming response time of less than 5 millisecond. The instrument makes 700 discrete measurements per sec on command, or may be optionally fitted to measure up to 50,000/sec.—E-H Research Laboratories Inc.

Circle 153 on Reader Service Card

A-TO-D CONVERTER

Model 143A analog-to-digital converter is a complete, high-speed seven-bit instrument in compact AEC standard nuclear module packaging. It is designed to digitize nanosecond photomultiplier pulses directly and give direct readout on magnetic tape, an on-line computer or into a multichannel analyzer memory. It combines a linear gate, stretcher amplifier, amplifier-to-time converter, clock, scaler and output multiplexer in one package.—LeCroy Research Systems Corp.

Circle 154 on Reader Service Card

LOGIC SYSTEMS

Nanologic Systems 200 and 150 are said to provide, for the first time, 200 Mc logic operation for physics experimentation combined with stability, accuracy, uniformity and ease of operation. System 200 is packaged in standard module configuration and is compatible with Nanologic System 100. System 150 is packaged in accordance with the AEC NIM standard and provides the same operation and capabilities as System 200. Both systems offer better than 5-

nanosec resolution on discriminators, complete d-c coupled circuitry and continuously variable output widths over a range of 5 nanosec-5 microsec.—Chronetics Inc.

Circle 149 on Reader Service Card

MOSSBAUER SPECTROMETER

This Mossbauer spectrometer is based on the latest design of the National Bureau of Standards and is intended for 20 cm/sec operation in either constant acceleration or constant velocity modes. It is said to be capable of investigating most Mossbauer systems. A Cryotip accessory for absorber cooling is fitted.—Nuclear Science & Engineering Corp.

Circle 150 on Reader Service Card

DIGITIZER

Model FT-952 high speed digitizer is said to be the first high-speed waveform instrument to achieve accurate digitizing at data point intervals down to 1 microsec. A set of 1,024 data points can be obtained at a single stroke. The digitizer automatically reads out the recorded signal at a rate of 50 microsec/point. The signal averager measures this and adds it to the previously accumulated waveform information. — Fabri-Tek Inc.

Circle 151 on Reader Service Card

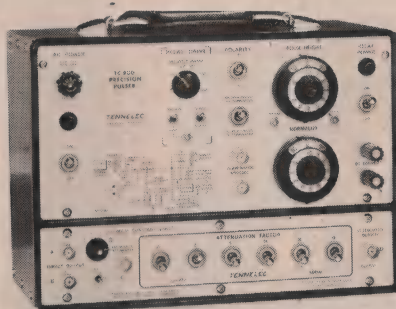


SIGNAL CORRELATOR

Intended for detection, measurement or comparison of noisy signals, the Model 100 signal correlator is said to make more practical the applications of auto- and cross-correlation signal processing techniques in many fields. The instrument operates in real time with input frequencies ranging from d-c to 300 kHz. One hundred points of the auto- or cross-correlation function are continuously computed over time delay spans ranging from 100

microsec to 1 sec.—Princeton Applied Research Corp.

Circle 133 on Reader Service Card



PRECISION PULSER

TC 800 Precision Pulsar is a very stable mercury relay pulse generator intended for setup, calibration, proof-of-performance etc. for high-resolution nuclear spectrometers. The effect on output voltage of a 10 C temperature variation or a 50% line voltage change is less than 0.02%. Active elements are all silicon. The instrument has non-inductive 0.1% wirewound resistors in the attenuator, choice of 50-Ohm, 93-Ohm, binary sequence or decimal sequence attenuator, and other features.—Tennelec Instrument Co. Inc.

Circle 136 on Reader Service Card

VOLTMETER

Series 5050 proximity voltmeters have dynamic capacitor detector probes to allow non-contacting voltage measurement from 1 volt to 3,000 volt full scale. Accuracies of better than 1% can be achieved and 100% feedback operation provides maximum insensitivity to variations in spacing between probe and surface. Selectable voltage ranges are $\pm 1, 3, 10, 30, 100, 300$ and 1,000.—The Victoreen Instrument Co.

Circle 137 on Reader Service Card

8-MEV ACCELERATOR

Model T8/50 is a Van de Graaff accelerator capable of providing high-current performance at proton energies up to 8 Mev. It is designed for university physics research and teaching and is a two-stage tandem accelerator with convertibility to single-stage operation. Operating in tandem mode the machine will provide proton energies continuously variable from 2 to 8 Mev. Guaranteed proton current rating is 50 microamps at 2 Mev.

(continued)

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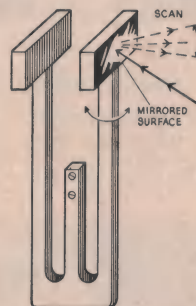


Bulova's American Time Products division has a patent pending on an important innovation in tuning forks: By affixing to the fork's tines a pair of vanes which can be slotted, notched or pierced as desired, the fork can be made to chop light or similar energy beams—making possible optical effects never before achieved.

Bulova fork light choppers offer great advantages over motor-driven types: There are no wearing parts—no lubrication is required—operational life is many times longer! Forks handle light more efficiently. They are smaller and lighter than any other chopper. Example: A 2 cu. inch package can chop 1,000 times per second!

And Bulova keeps coming up with important improvements. Among the latest—forks can now be supplied with peak-to-peak time excursions of $\frac{3}{8}$ " at 200 cps.

In addition, Bulova has recently patented torsional tuning forks. Each tine twists about its own axis independently, in opposite phase. This eliminates rate change



due to attitude or acceleration, and results in the most constant and uniform movement known. Bulova torsional forks can be used for any number of scanner variations—in spectrophotometers, automatic star tracking units and densitometers. Write for information.

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NEW PRODUCTS

Overall design aim of the machine is 200 microamps of proton current at 8 Mev. In single-stage mode the T8/50's proton energies are continuously variable from 1 to 4 Mev with a guaranteed 600 microamps of protons at 4 Mev.—High Voltage Engineering Cory.

Circle 138 on Reader Service Card

GAUSSMETER

Model FH-20 Hall-effect gauss-meter utilizes a temperature-controlled Hall-effect field-sensing

probe. It features $\pm 0.1\%$ accuracy to 30 kgauss, 50 mG resolution and resetability over full range, digital decade dials with null meter, one probe for full field range, complete solid state design and through zero field measuring capability.—Varian Associates analytical instrument div.

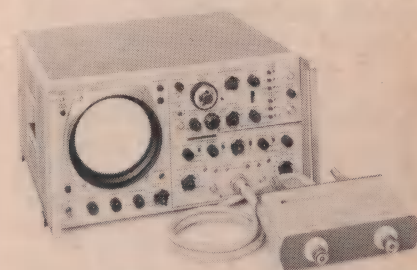
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LIGHT MODULATORS

This series of low-voltage optical light modulators permit modulation

at optical frequencies with voltages as low as 100 volt. Mechanical resonances have been reduced to negligible proportions to allow flat response from d-c to 100 MHz. The optical transmission has been extended to cover the ultraviolet and the near-infrared. All models have a standard 5 mm by 5 mm aperture and an isolated ground connector.—Isomet Corp.

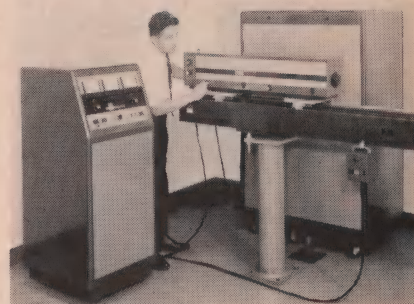
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SAMPLING OSCILLOSCOPES

This series of sampling oscilloscopes reveal waveforms with bandwidth beyond 12.4 GHz. CW signals can be observed directly through an X-band. Sensitivity from d-c through 12.4 GHz is 1 mv/cm. Pulse carriers can be viewed directly, without degradation of pulse wave-shape. Time domain reflectometry is comparably extended, for discontinuities only millimeters apart can be resolved.—Hewlett-Packard Co.

Circle 144 on Reader Service Card



LASER SYSTEMS

Series 300 laser systems are modular in design but are packaged systems rather than components mounted on an optical bench. The series provided nine configurations. Basic is the use of a low-level oscillator followed by high efficiency amplifiers, a concept which lowers the stress level on Q-switching components and enhances their reliability. Careful attention to thermal control within the laser unit permits equipment upgrading to higher cycle rates with power unit modification only. The three models have re-

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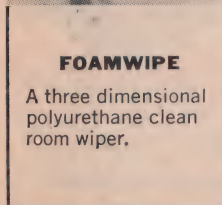
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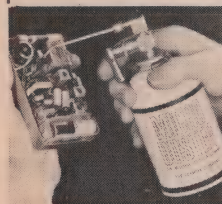
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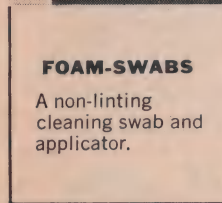
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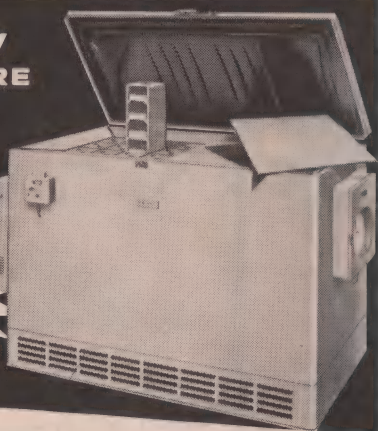
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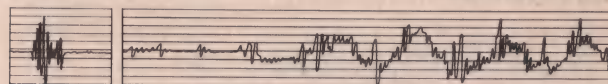
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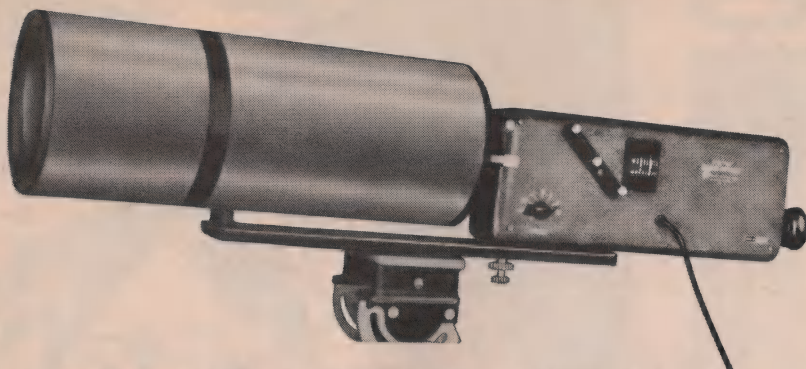
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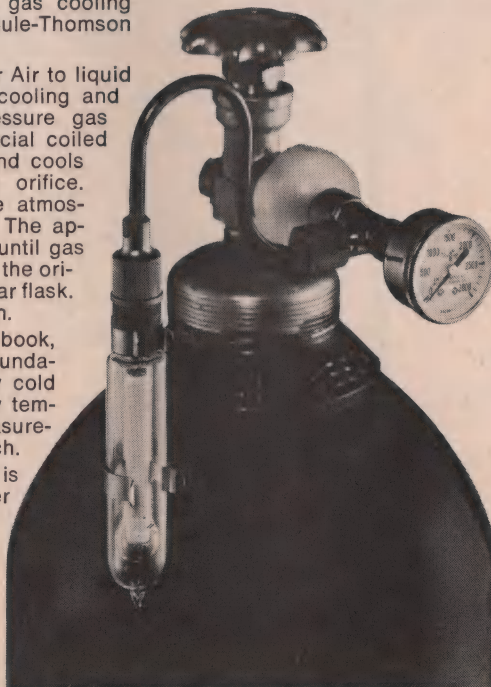
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NEW PRODUCTS

petition rates from 2 ppm to 5 pps. Model 301 has an output of 250 mw Q-switched at 2 ppm, Model 302 output is 600 mw at 2 ppm, and Model 303 output is 1 gigawatt Q-switched at 2 ppm.—TRG Control Data Corp.

Circle 174 on Reader Service Card

ZONE REFINER

Multizone I is intended for zone refining organic and inorganic chemicals. It may be used with many materials and in applications requiring zone refining, zone leveling, normal freezing and single crystal growth. The equipment will refine compounds having melting points in the range room temperature-300 C. When placed in a cold chamber the apparatus can be used for materials having melting points at room temperature and below.—Materials Research Corp.

Circle 140 on Reader Service Card



HELIUM REFRIGERATOR

Model 340LS helium refrigerator is a 20 K ADL Cryodyne and has applications in electron beam and Bremsstrahlung beam experiments. Refrigerator and target are mounted in the synchrotron vacuum chamber in a straight section between guide-field magnets. The refrigerator can operate for 3,000 hours continuously before preventive maintenance. It provides 3 watts of refrigeration at 20 K.—Arthur D. Little Inc.

Circle 147 on Reader Service Card

DIGITAL RECORDER

This digital recording accessory is designed for converting data rep-

resented by the counter, on the pressure gauge, into digital data in the form of voltage levels. The output may be used to operate a printer or as an input to a digital computer. Special outputs are available to make the system compatible with computer card punches, paper tape punches and telemetering systems. Standard logic is 0 to 9 volt d-c for logical "zero" and "one" respectively.—Texas Instruments Inc.

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ION PUMP

The Electro Ion is said to be a completely new concept in ion pumps design. It is an electrostatic getter ion pump which produces high-speed oil-free pumping without restrictions of heavy magnets.

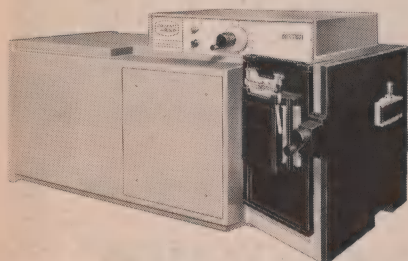
—Granville-Phillips Co.

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VACUUM SPECTROGRAPH

Model E-580 2-meter grazing incidence vacuum spectrograph is arranged vertically, with the entrance slit horizontal. A photo-electric scanning attachment allows one to use the instrument as a scanning spectrometer in addition to its spectrographic capabilities. The range of 5-950 Å allows investigation of phenomena in the soft x-ray and extreme vacuum ultraviolet regions. Of particular interest in many applications is its non-magnetic feature: the instrument is constructed of magnesium/zirconium alloy.—Engis Equipment Co.

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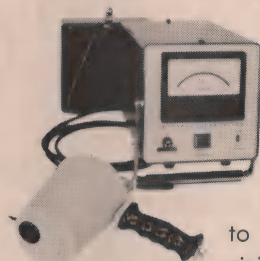


SPECTROMETER/SPECTROGRAPH

Model 25-100 Double Czerny-Turner Combination spectrometer/spectrograph is designed for stray light reduction. It consists of two monochromators mounted in a vertical arrangement with a horizontal intermediate slit between the two sections. The gratings are mounted on a common pivot, one above the other. The

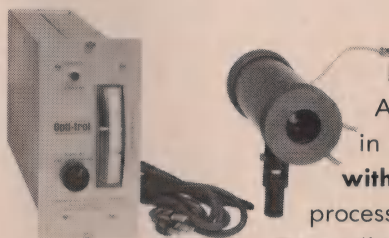
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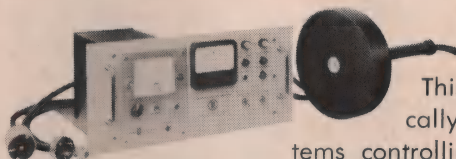
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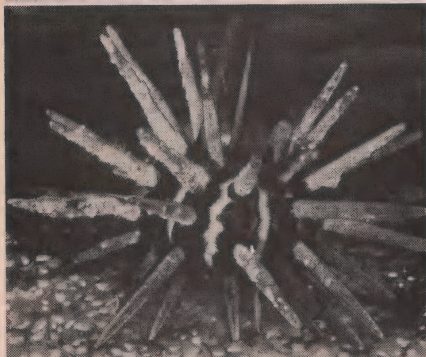
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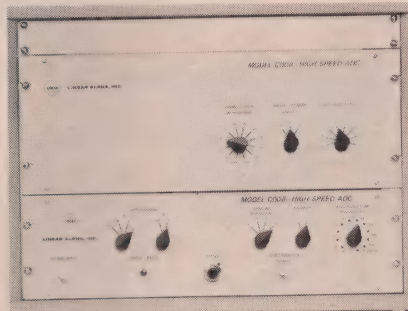
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NEW PRODUCTS

system has the advantage that the first monochromator may be used independently by the addition of a swing-out mirror assembly and a second exit slit on the first monochromator.—Jarrell-Ash Co.

Circle 176 on Reader Service Card



INTEGRATING ADC

This high-speed, integrating analog-to-digital converter, designated Model C008, is designed for recording digital waveforms and enhancing signal-to-noise ratio. The input is divided into periodic intervals selectable from 1 microsec to 512 microsec each. Each interval is first integrated and then digitized. Output is a digital word for each interval, consisting of a timing bit, an overflow bit, and five through 12 data bits in pure-binary, parallel format.—Linear Alpha Inc.

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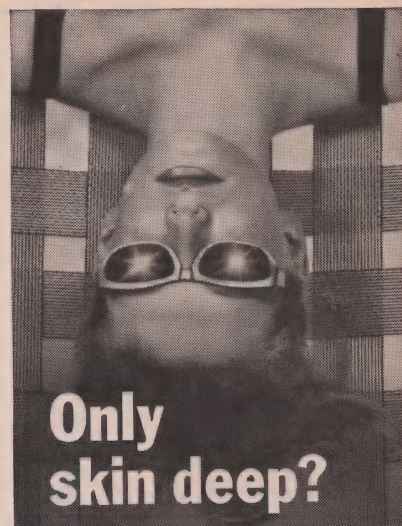
NITROGEN REFRIGERATOR

The Cryo-Tip nitrogen refrigerator is intended for single-crystal x-ray studies and is said to be unique in that refrigeration is produced only at the very small tip supporting the single crystal. This eliminates the conventional annoyances of frost, flutter etc. present with cold-gas systems. Precise temperature control is possible. The system is designed to fit directly on an eucentric goniometer mount. Temperature range of the instrument is 80 K-300 K, with a cool-down time of 5-8 min.—Air Products and Chemicals Inc.

Circle 135 on Reader Service Card

LASER SYSTEM

Series 1400 high repetition rate laser system has an output wavelength of 6,943 Å and 1.0 microns, and output power of 250-300 Mw. Repetition rate is up to 1 pps, with output energy Q-switched as 2-3 Joules typical. Output energy non-Q-switched is 20-30 Joules typically. The system has a pulse duration



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Index for Advertisers and Advertising Agencies

Name of advertiser	Page number
Ainsworth & Sons, Inc., Wm.	58
Broyles, Allebough & Davis, Inc.	
Amperex Eleceronic Corp.	4
Sam Groden, Inc.	
Ampex Corp.	65
Young & Rubicam, Inc.	
Aquarium Systems, Inc.	68
Brand Advertising	
Barnes Engineering Co.	67
Albert A. Kobler Co., Inc.	
Beckman Instruments, Inc.	2
Hixon & Jorgensen, Inc.	
Brush Instruments Division	11
Carr Liggett Advertising, Inc.	
Buchler Instruments	60
Selvin & Jaffe	
Bulova Electronics Div. of Bulova	
Watch Co., Inc.	63
Frank Best & Co., Inc.	
Camberra Industries, Inc. Sturup	
Nuclear Div.	22
William J. McKee Associates	
Corning Glass Works	14
Rumrill-Hoyt, Inc.	
Coulter Electronics Inc.	30
Leonard Primer Corp.	
Digital Equipment Corp.	33
Kalb & Schneider, Inc.	
Dunhill of Boston, Inc.	65
Jack Spiro Co.	
Dupont, Freon Products Division	16
Batten, Barton, Durstine & Osborn, Inc.	
Dupont, Instrument Product Division	51
Rumrill-Hoyt, Inc.	
Granville-Phillips	1
Tallant/Yates Advertising, Inc.	
Hewlett-Packard, Colorado Springs Div. 2nd Cover	
Tallant/Yates Advertising, Inc.	
Hewlett-Packard, F & M Scientific Div.	18
Richardson, Thomas & Bushman, Inc.	
High Voltage Engineering Corp.	57
Kenyon & Eckhardt, Inc.	
Hitachi, Ltd.	62
Martin Wolfson Advertising	
Keithley Instruments, Inc.	7
The Bayless-Kerr Co.	
LABEN (Laboratori Elettronici e Nucleari)	10
Pericchi Clara	
LeCroy Research Systems	31
Caroe Marketing, Inc.	
Matheson Co., Inc.	66
Leonard M. Sive & Associates	
Melpar, Inc.	69
Arthur J. Lamb, Inc.	
3M (Minnesota Mining & Mfg. Co.)	20
MacManus, John & Adams, Inc. Adv.	
Nalge Co., Inc., The	6
Wolf Associates, Inc.	
Nuclear-Chicago Corp.	54
Sidney Clayton Associates	
Nuclear Data, Inc.	3rd Cover
Geyer, Morey, Ballard, Inc.	
ORTEC	24
Thomas R. Sundheim, Inc.	
Packard Instrument Co.	9
Ross Llewellyn, Inc.	
Photo Research Corp.	66
Gordon H. Dibble Co.	
Power Designs, Inc.	70
Taube/Violante, Inc.	
Princeton Applied Research	12
Mori Barish Associates	
RCA Electronic Components & Devices	32
Al Paul Lefton Co.	
Revco, Inc.	65
The Jaqua Co.	
Sorval, Inc., Ivan	50
A. B. W. Toft & Co.	
Texwipe	64
Armand Richards Advertising Agency	
Unitron Instrument Co.	8
Van Christo Associates, Inc.	
Vanguard Instrument Corp.	58
Lewis Hunt & Harland Associates	
Victoreen Instrument Co.	4th Cover
Palm & Patterson, Inc.	
West Eleven, Inc.	62
Martin Wolfson Adv.	
Whittaker Corp., Gencom Div.	56
A. D. Adams Advertising	

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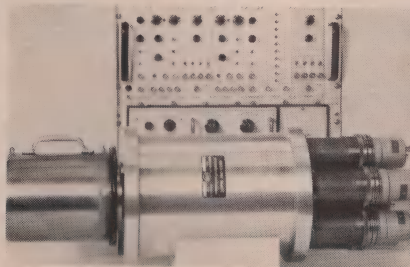
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94 95 96 97 98 99 100 101 102 103 104 105 106 107 108

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135 136 137 138 139 140 141 142 143 144 145 146 147
148 149 150 151 152 153 154 155 156 157 158 159 160
161 162 163 164 165 166 167 168 169 170 171 172 173
174 175 176 177 178 179 180 181 182 183 184 185 186
187 188 189 190 191 192 193 194 195 196 197 198 199
200 201 202 203 204 205 206 207 208 209 210 211 212
213 214 215 216 217 218 219 220 221 222 223 224 225

PRODUCT SURVEY

226 227 228 229
230 231 232 233
234 235 236 237
238 239 240 241
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161 162 163 164 165 166 167 168 169 170 171 172 173
174 175 176 177 178 179 180 181 182 183 184 185 186
187 188 189 190 191 192 193 194 195 196 197 198 199
200 201 202 203 204 205 206 207 208 209 210 211 212
213 214 215 216 217 218 219 220 221 222 223 224 225

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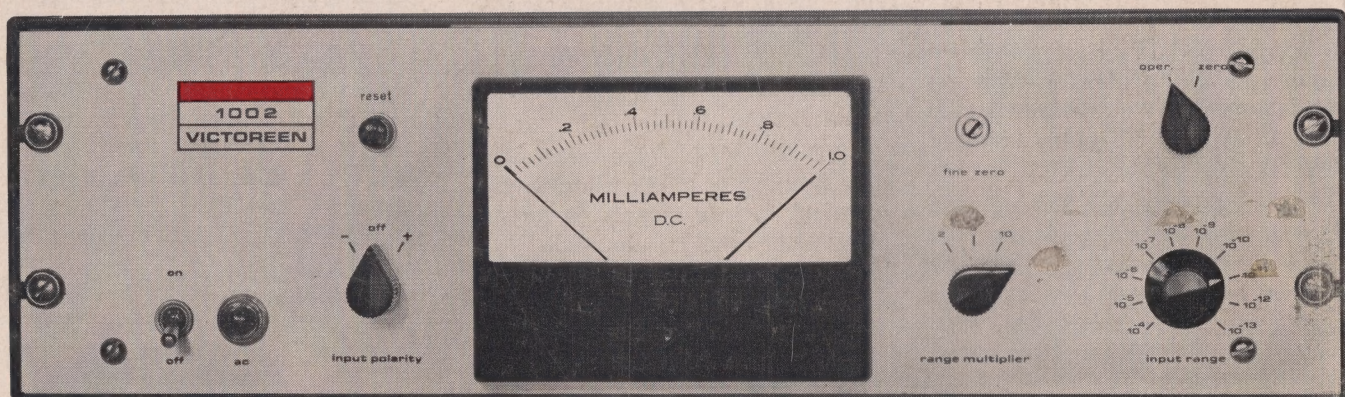


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Stability	0.5%/day (after ½ hour warm-up)	0.5%/day (after ½ hour warm-up) except 10 ⁻¹³ range where it is 1%, 2% or 5% depending on range multiplier setting
Accuracy Recorder Output (add 1% for panel meter readings)	1% to 10 ⁻¹⁰ 2% to 10 ⁻¹¹	1% to 10 ⁻¹⁰ 2% to 10 ⁻¹³
Input Current Polarity	Pos or neg. Selected by function switch on front panel	Pos or neg. Selected by function switch on front panel
Bucking Current Source	10 ⁻³ to 10 ⁻⁹ amp pos or neg in 7 steps	—
Time Constants	0.1, 0.3, 1, 3, 10 & 30 sec, switch selected	Approx. 0.3 sec on most sensitive range (open input). Proportionately less on other ranges.
Input Connectors	BNC type UG 657/U	BNC type UG 931/U
Recorder Output	± 10mv at 1ma	± 10V; ± 10mv & 5ma
Detector Supply Voltage	150V regulated output provided by rear panel connector for ion chamber operation	150V regulated output provided by rear panel connector for ion chamber operation
Power Requirements	½ amp at 115V, 60 cycle	½ amp at 115V, 60 cycle
Dimensions	19 wide x 10 deep x 5¼" high (relay rack panel)	19 wide x 10 deep x 5¼" high (relay rack panel)
Cabinet (optional)	Model 800-20 as shown	Model 800-20 as shown

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MODEL 1002



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